DESIGNING AGAINST HABITAT LOSS:
FACILITATING MOVEMENT OF THE LOUISIANA BLACK BEAR

BY

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THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Landscape Architecture in Landscape Architecture
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2020

Urbana, Illinois

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ABSTRACT

To support the continued survival of the Louisiana black bear (*Ursus americanus luteolus*), and preserve and protect the greater ecological communities of the bottomland hardwood forests that it occupies, this thesis proposes a catalog of design interventions that facilitate (1) the connectivity of Louisiana black bear subpopulations, (2) climate-related migration of the subspecies, and (3) more amicable coexistence of bears and humans.

In May 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) released its Global Assessment Report on Biodiversity and Ecosystem Services, and it foretold of a grim future for wildlife worldwide. The report specifically noted human alteration of land and climate change as major factors contributing to ecosystem deterioration and biodiversity loss.[1] This combination of factors is particularly relevant in the South-Central United States, where fertile soils have made cropland (namely soybean, corn, and cotton fields) a significant portion of the landscape, and rising temperatures and sea levels, coupled with extreme weather events, threaten to erase and further fragment any suitable habitats that do remain.

The Louisiana black bear faces especially acute problems as a large mammalian predator, due to expansive spatial requirements and lack of eager reception by many humans. Its population has been reduced to around 750[2] and is exclusively found in four subpopulations in Louisiana, with this spatial isolation adding to the fragility of the subspecies as a whole.[3] Though this culturally and ecologically important subspecies is no longer on the US Fish and Wildlife Service endangered species list, many believe that support and an active restructuring of landscapes is necessary to guarantee survival.[4] As the Louisiana black bear is considered an umbrella species, conservation of it and its habitat would be beneficial to a wide array of species, including humans.

[1] "IPBES Global Assessment Report," World Wildlife Fund for Nature, accessed April 14, 2020, https://lp.panda.org/ipbes.
[2] Alexander Jusdanis, "The Bear That Went from Presidential Namesake to Political Pawn," The Outline, accessed April 14, 2020, https://theoutline.com/post/6442/louisiana-black-bear-endangered-species-list.
[3] Joseph D. Clark et al., "Connectivity among Subpopulations of Louisiana Black Bears as Estimated by a Step Selection Function: Connectivity Among Louisiana Black Bear Subpopulations," The Journal of Wildlife Management 79, no. 8 (November 2015): 1347–60, https://doi.org/10.1002/jwmg.955.
[4] Jusdanis, "The Bear That Went from Presidential Namesake to Political Pawn."

ACKNOWLEDGEMENTS

This thesis would not have been possible without the guidance and mentorship of my advisor, Conor O'Shea. His encouragement, enthusiasm, and expectations helped me surpass my own notions of what I was capable of. I am extremely grateful for all the time and energy he put into advising me and fostering my interest in wildlife-focused design.

I am also very grateful to the other members of my committee, Craig Reschke and Dr. Jared Duquette, for their excellent feedback, fruitful suggestions, and continued support. Getting the opportunity to work with a wildlife ecologist not only helped ground my design but consistently renewed my excitement in the topic.

My thanks also go out to the large number of professionals and academics I contacted that were willing to have discussions with me and help me learn as much as I could about the topic. Being able to talk to someone that you have already cited in your bibliography is extremely exciting and their willingness to chat was impressive.

Lastly, I would like to thank all of my family, friends, and classmates that supported and encouraged me during this journey.

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CHAPTER 1: INTRODUCTION

In May 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) released its Global Assessment Report on Biodiversity and Ecosystem Services, and it foretold of a grim future for wildlife worldwide. The report posited that changes in land and sea use, direct exploitation of organisms, climate change, pollution, and invasive species would all significantly contribute to a massive decline in biodiversity.[5] All of these forces doubtless affect human health as well, but in the realm of changing land use, wildlife is especially vulnerable. As Michael Rosenzweig asserts in his book *Win-Win Ecology*, when land is divided between humans and animals, the party doing the dividing (the humans) will always win when conflict arises.[6] This thesis aims to counteract this imbalance by designing against habitat loss, engaging in what landscape architect Kate Orff describes as "mutualism by design."[7]

The product of this research, explored in-depth in Chapter 5, is a catalog of design interventions that facilitate (1) the connectivity of Louisiana black bear subpopulations, (2) climate-related migration of the subspecies, and (3) more amicable coexistence of bears and humans. These designs will benefit not only the Louisiana black bear as a subspecies, but will also, by necessity, preserve and protect the multitude of ecological communities that the bear inhabits, such as the bottomland hardwood forest. Protection of this ecosystem is, in turn, valuable for an abundance of species, including humans. By spatializing, designing, and enacting what Rosenzweig calls "reconciliation ecology" on a regional scale, this project redefines what it thought of as "human" and "animal" space in Louisiana, creating a model for landscape architecture as a means toward cohabitation without conflict.

[5] "IPBES Global Assessment Report."
[6] Michael L. Rosenzweig, *Win-Win Ecology: How the Earth's Species Can Survive in the Midst of Human Enterprise* (Oxford University Press, 2003), 9.
[7] Kate Orff, *Toward an Urban Ecology* (Monacelli Press, 2016), 83.

CHAPTER 2: CASE STUDIES

A thorough understanding of existing landscape architecture projects related to wildlife is necessary for both the theoretical placing of one's own design in the milieu and for understanding the many ways designers create spaces for other species. To this end, an analysis of fourteen landscape architecture and architecture projects with a focus on wildlife was a necessary starting point for this thesis. The full list of projects can be found in Table 1. The impact of selected projects on this thesis are discussed in detail below.

Table 1. Wildlife Design Case Studies (Location, Year, Species of Focus)

- Caribou Pivot Stations – Lateral Office (Nunavut, Canada; 2010; caribou)
- Green Connections Network – San Francisco Planning Dept., Nature in the City, and collaborators (San Francisco, California; 2014)
- Synanthropic Suburbia – Sarah Gunawan (Suburban Ontario, Canada; 2015)
- Oyster-Tecture – SCAPE (Brooklyn, New York; 2010; oysters)
- Bat Billboard – Chris Woebken and Natalie Jeremijenko (2009, bats)
- Hidden in Plain Sight – Ants of the Prairie (Matadero, Madrid, Spain; 2019; insects)
- 20KM Spectrum – Lateral Office (Montreal, Canada; 2011)
- Safari 7 – SCAPE (New York, New York; 2010)
- Pier 35 – SHoP and Ken Smith Workshop (Manhattan, New York; 2019; mussels)
- Orange County Great Park – Ken Smith Workshop and Mia Lehrer + Associates (Irvine, California; 2006)
- hypar-nature (ARC Wildlife Bridge) – HNTB Engineering and MVVA (Denver, Colorado; 2010-2015)
- Amphibious Architecture – Chris Woebken in collaboration with xClinic and The Living (New York, New York; 2009; fish)
- Central Seawall Project – James Corner Field Operations (Seattle, Washington; 2018; salmon)
- Ecological Energy Network – FABRICations, Lola, and Studio 1:1 (Netherlands, 2014)

2.1 Caribou Pivot Stations – Lateral Office

This research-intensive project focuses on the effects of global warming on caribou in Nunavut, Canada. Not only do its spatial analysis and ecological research provide rationale for

the final design, but the design itself capitalizes on anticipated investments in other types of infrastructure. As one of the few projects I found that addresses the needs of a single large mammal species, the level of specificity in Caribou Pivot Station's species analysis served as a precedent for me in my own research.

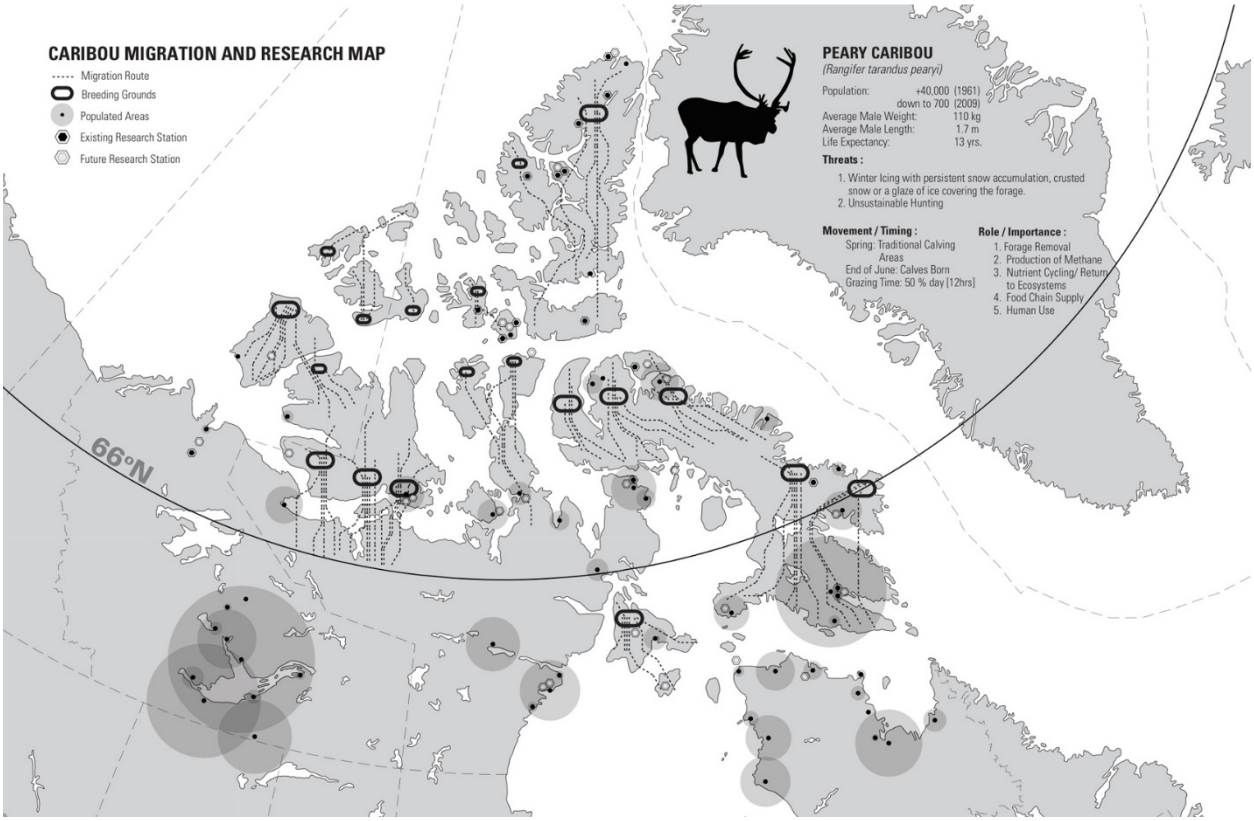

Figure 1. Caribou Ecology and Migration Map in Relation to Research Stations
Image Source: http://lateraloffice.com/CARIBOU-PIVOT-STATIONS-2010

2.2 hypar-nature (Arc Wildlife Bridge) – HNTB Engineering and MVVA

As the winning entry in the ARC International Wildlife Crossing Infrastructure Design Competition, hypar-nature focuses on the concept of repeatability, not only in terms of structure, but environment as well. Designers of hypar-nature made it clear that their bridge was not meant to replicate nature, but to "[condense] and [amplify] multiple landscape bands (Forest, Meadow, Shrub, Scree) into habitat corridors that provide connections for a larger cross-section of species."[8] This manner of design thinking puts the emphasis on the unique

[8] Michael Van Valkenburgh Associates, Inc., "ARC Wildlife Bridge," Projects, accessed April 19, 2020, https://www.mvvainc.com/project.php?id=89.

ability of the designer to change the environment without having to restore it to its "natural state." This idea gives landscape architects a unique place in the wildlife conservation discussion. Though ecologists, biologists, and other scientific experts should certainly be consulted when working on projects focused on wildlife, designers bring the ability to create new spaces with potential that might not be found in traditional restoration ecology. This mindset helped inform the design decisions made in this thesis project.

Figure 2. Plan View of hypar-nature (ARC Wildlife Bridge)
Image Source: https://www.mvvainc.com/project.php?id=89

CHAPTER 3: GEOGRAPHICAL ANALYSIS

3.1 National Analysis

Although human spaces and animal spaces are often divided, whether by fence, municipal code, or psyche, the two often overlap significantly. It is in the spaces with the most overlap where conflict typically occurs. As Richard Weller notes: "Typically, attempts to reconnect fragments of extant habitat in highly modified landscapes run against the grain of the cadaster, conflict with political boundaries, and clash with agricultural logistics and infrastructure."[9] We can visualize this problem by examining land use patterns on a broad scale. Protected areas, depicted in light blue in Figure 3, make up a significant portion of land in the western United States. The International Union for the Conservation of Nature (IUCN) defines a protected area as a "clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values."[10] Although some of this land is mixed-use, relative to other land-use types, this land is more likely to serve as viable animal space.

The area of the map least covered in protected area is the central United States, including midwestern and south-central states. From Texas up to North Dakota and east to West Virginia and the Appalachian Mountains, we see that cropland, depicted in pink, takes up a majority of the land. The middle of the country features a very high ratio of cropland (human space) to protected areas (animal space) compared to either coast. Because the land in this area has been found so suitable for farming, wildlife native to the area have lost large swaths of their territory to the will of humans. Figure 4 shows that these cropland-heavy areas are largely devoid of American black bears, even though the species used to cover almost the entirety of the United States and Canada.

[9] Richard Weller, "Stewardship Now? Reflections on Landscape Architecture's Raison d'être in the 21st Century," Landscape Journal 33, no. 2 (2014), 95.
[10] "About," Protected Areas, International Union for Conservation of Nature, accessed April 18, 2020, https://www.iucn.org/theme/protected-areas/about.

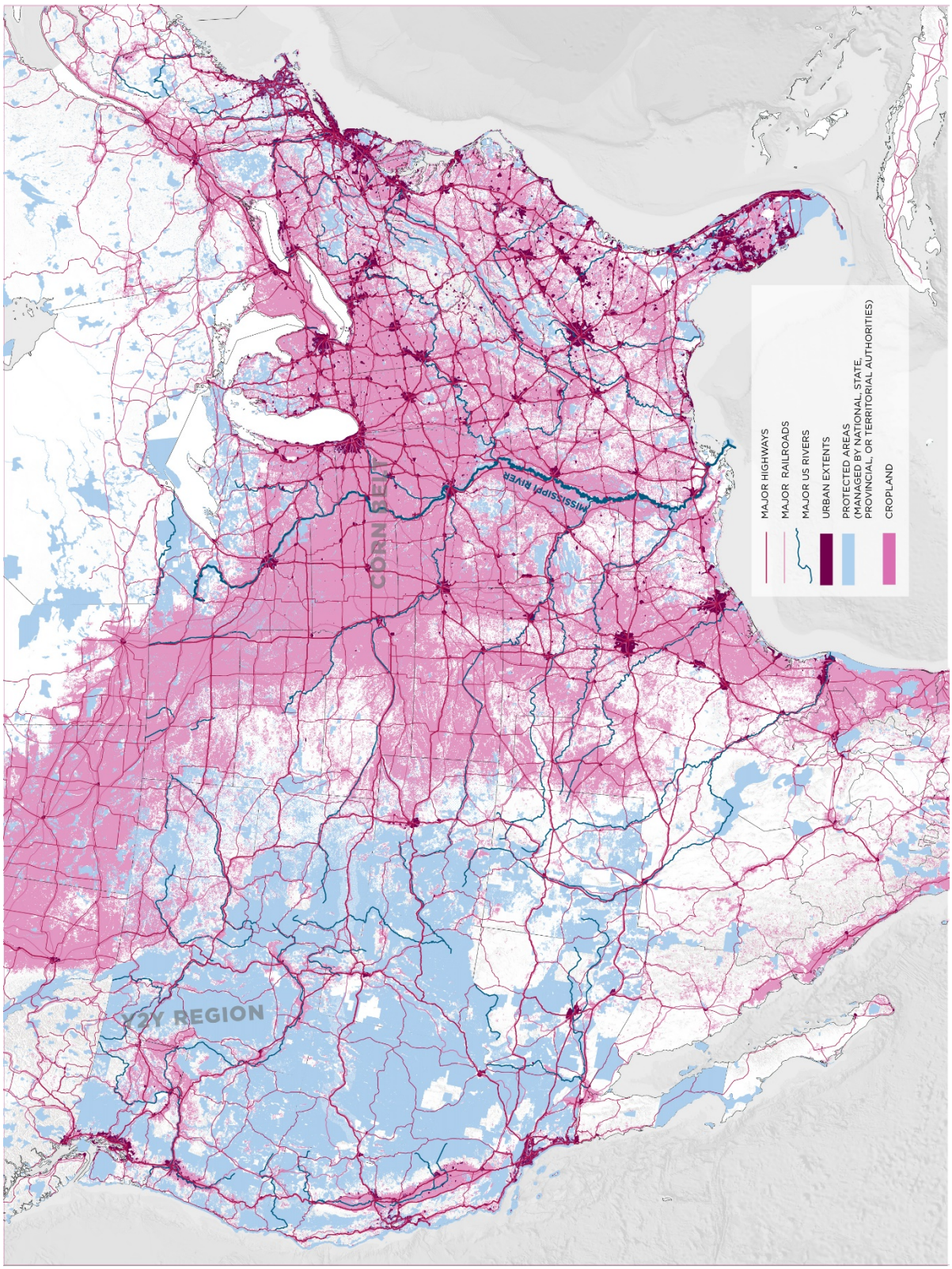

Figure 3. Land Use Analysis of the Continental United States

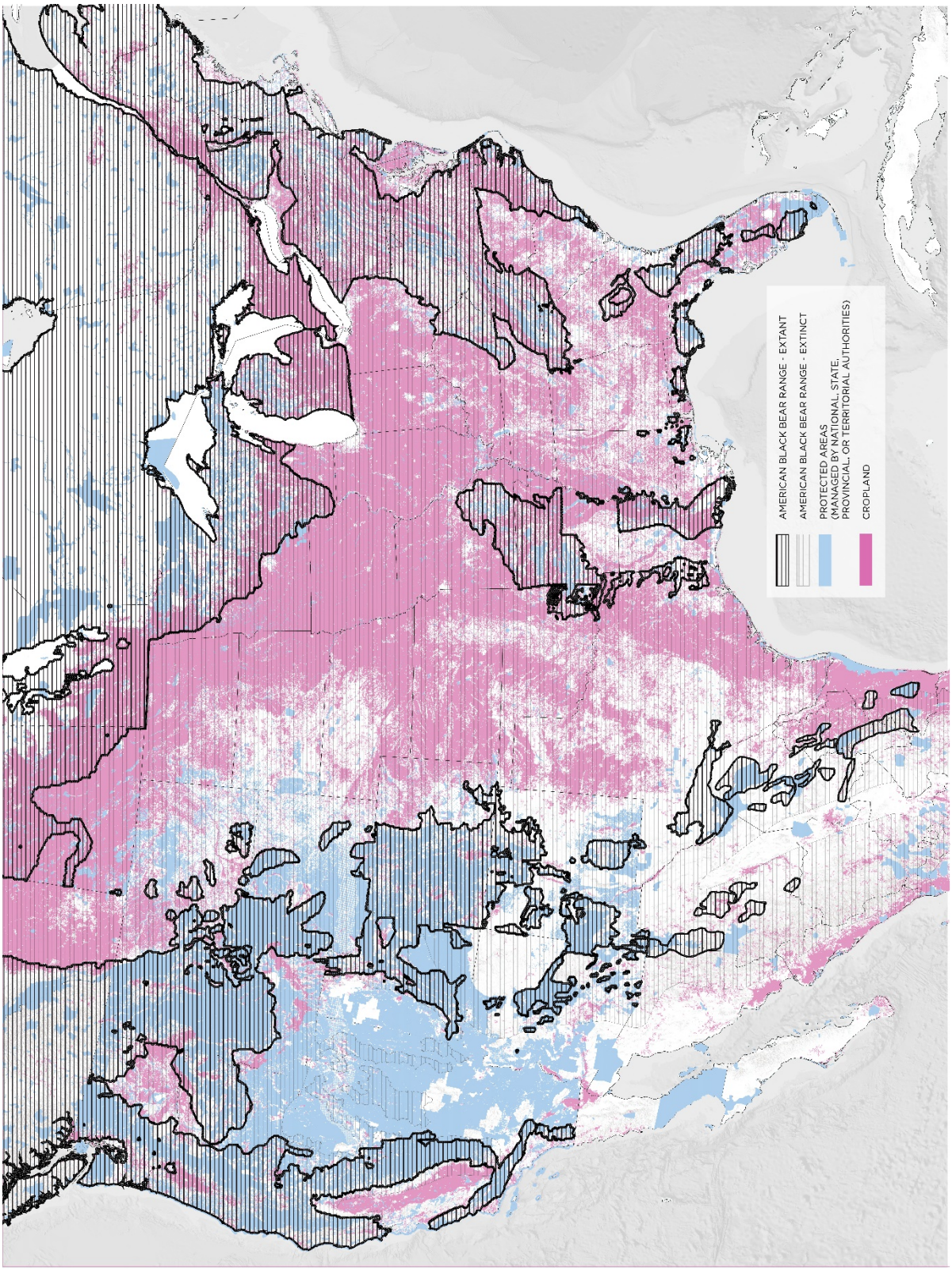

Figure 4. Land Use Compared to American Black Bear Range (Data Sources in Bibliography)

In the south-central US, climate change makes this problem of habitat loss especially urgent. What small areas of suitable habitat that are left are threatened not only by rising temperatures related to climate change, but also the threat of sea level rise and other extreme weather events in the Gulf of Mexico[11]. Coarse projection of climate-related migration, considering the movement of "many species across a large extent," predicts overall movement to trend either upward in elevation or latitude.[12] For species that will follow this trend in order to track climatic suitability, the relatively flat topography of the south-central United States narrows these options to the latter, but the Mississippi River presents unique potential for a migration corridor to the North. By focusing in on wildlife native to and dependent on habitats in Louisiana, this project addresses both the urgency of the situation and the opportunity presented by the river.

Despite the uniquely severe combination of habitat loss and climate change in the south-central states, there is a paucity of landscape architecture projects in the area working to address that problem. Figure 5 shows that the only project in this region that can be found in the Landscape Architecture Foundation's Landscape Performance Series with "Habitat" listed as a landscape performance benefit is in central Texas. A landscape architecture project with a wildlife focus in Louisiana will thus fill a very important need for conserving biodiversity.

[11] Kevin Fox Gotham, "Coastal Restoration as Contested Terrain: Climate Change and the Political Economy of Risk Reduction in Louisiana," Sociological Forum 31, no. S1 (2016): 787–806, https://doi.org/10.1111/socf.12273.
[12] J. J. Lawler et al., "Projected Climate-Driven Faunal Movement Routes," ed. N. Haddad, Ecology Letters 16, no. 8 (August 2013): 1014–22, https://doi.org/10.1111/ele.12132.

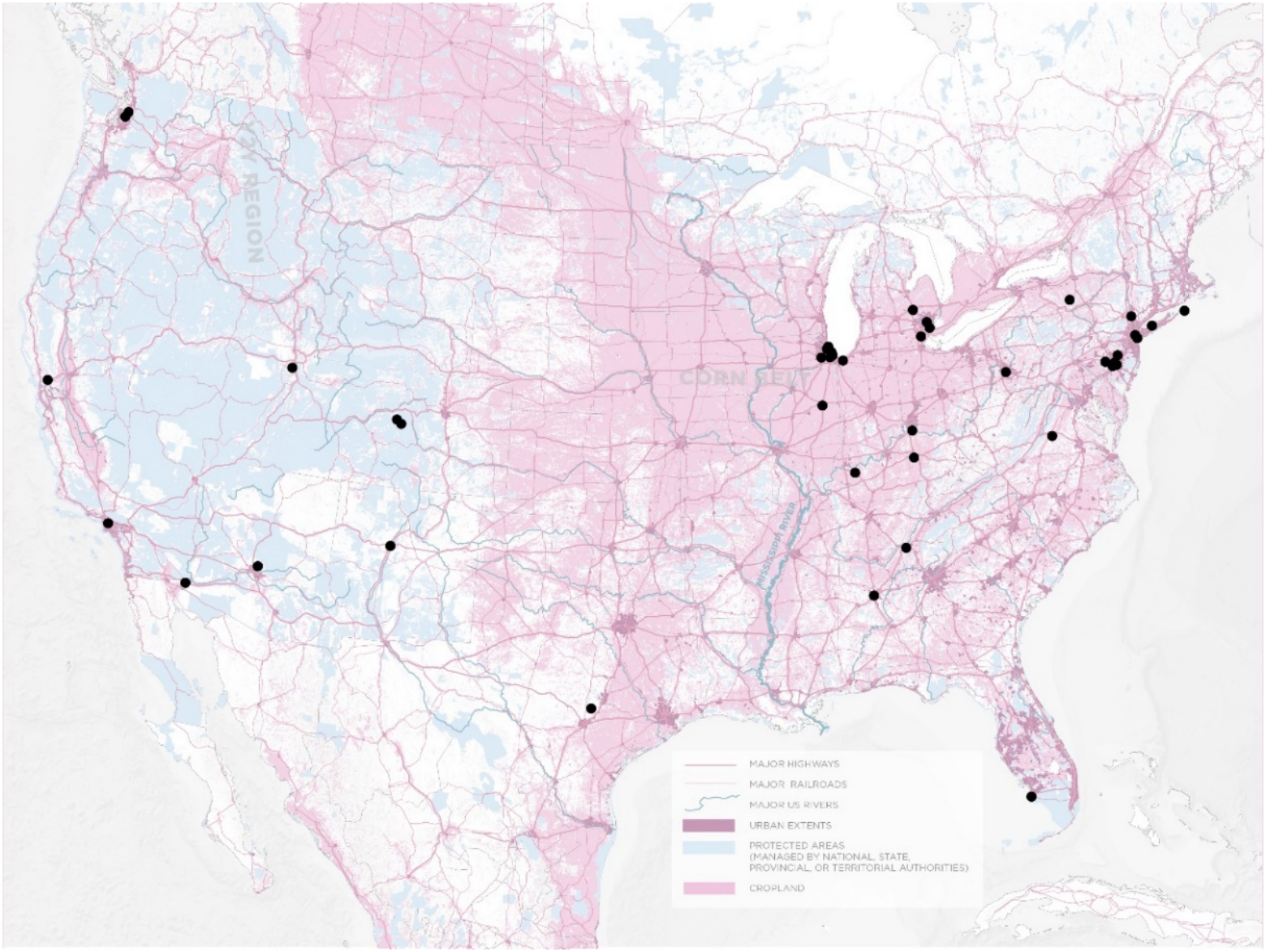

Figure 5. Locations of Projects with "Habitat" as a Landscape Performance Benefit in the Landscape Architecture Foundation's Landscape Performance Series (Data Sources in Bibliography)

3.2 Regional Analysis

In Louisiana, one of the species most affected by habitat loss is the Louisiana black bear (*Ursus americanus luteolus*). Its ecological role, controversial conservation history, and expansive spatial requirements, discussed more in the next chapter, make it the ideal candidate for design intervention focus in the area. Figure 6 depicts not only a larger scale map of the greater Louisiana region and its unique spatial relationships, but also shows how greatly the Louisiana black bear's habitat has been reduced. Historically, the subspecies occupied land ranging from Texas to Mississippi and northward into Arkansas. Its present-day breeding range is almost exclusively in eastern Louisiana, near the Mississippi River. Figure 6 also reveals that most of the land in-between patches of Louisiana black bear breeding range consists of cropland. In response to these conditions, much of the proposed design interventions, discussed in detail in Chapter 5, is either located in, adjacent to, or otherwise dealing with cropland as a spatial typology.

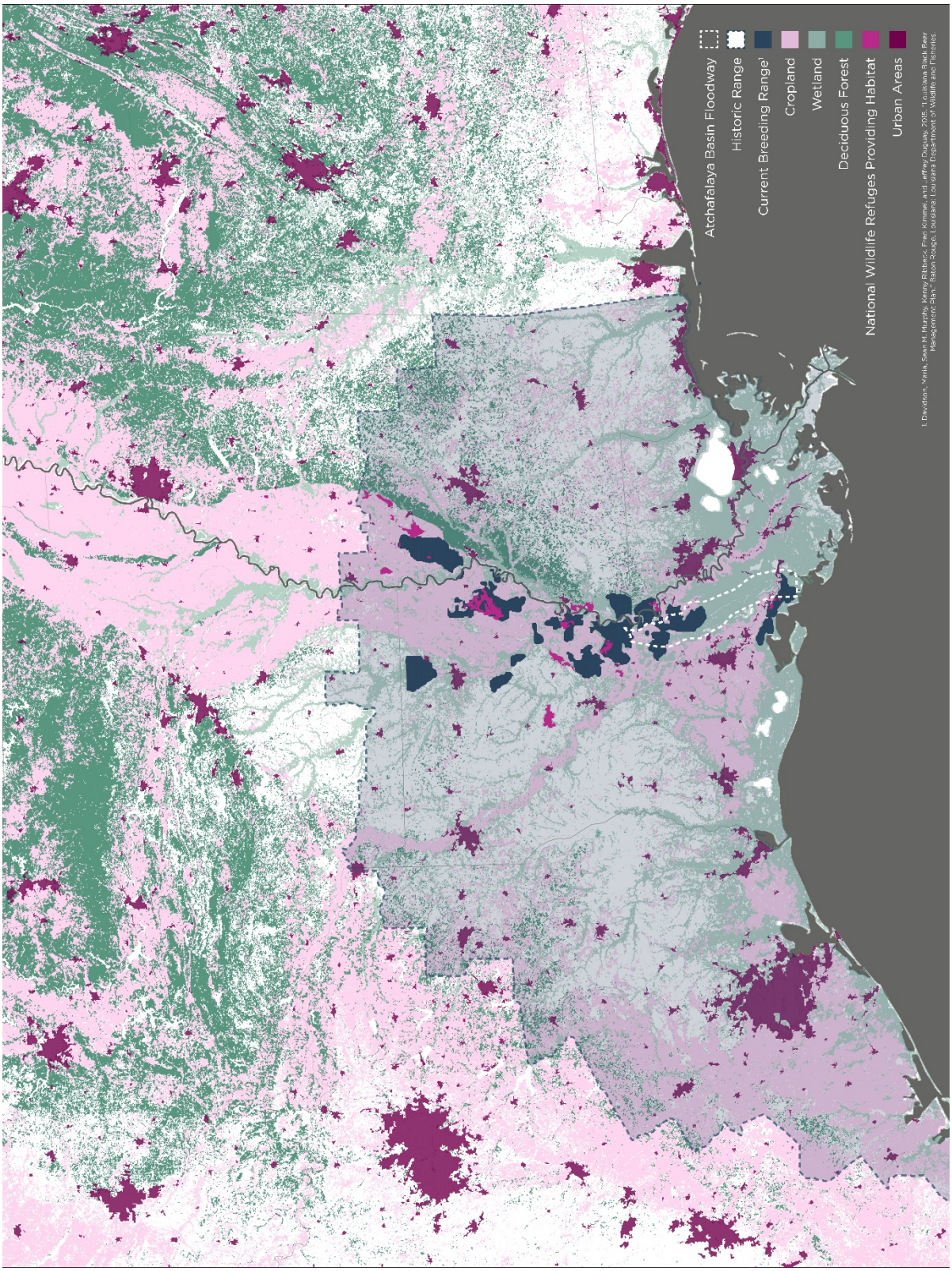

Figure 6. South-Central United States Regional Land Use Analysis and Louisiana Black Bear Ranges, Historical and Current (Data Sources in Bibliography)

CHAPTER 4: SPECIES RESEARCH

4.1 Ecological Role

The Louisiana black bear is the focus species for this project largely due to its prominent ecological role. The Louisiana black bear is considered an umbrella species. This means that conservation of the bear would also support the conservation of many other species. It receives this designation due to its large home range and utilization of a variety of habitat types.[13] Thus, although the focus of this project is on the bear specifically, it is likely that other species, such as Rafinesque's big-eared bats,[14] will also benefit from the designs. Among these benefitting species is the human, as this resulting increase in biodiversity would also have effects like supporting pollinators imperative to crop production. The Louisiana black bear serves not only as an umbrella species, but also as a potential founder population. This means that if its population continues to grow, and its range continues to spread (likely northward), the Louisiana black bear could eventually be further classified into different groups/subspecies.

Additionally, the Louisiana black bear's preferred environment is bottomland hardwood forest, an ecosystem with great potential for green infrastructure and other larger environmental benefits. A great deal of intact bottomland hardwood habitat in Louisiana is found in the Atchafalaya flood basin (*fig. 6*). In fact, according to the Atchafalaya National Heritage Area's website, "The Basin contains the largest contiguous bottomland hardwood forest in North America and is the largest overflow alluvial hardwood swamp in the United States."[15] Preservation of this bottomland hardwood forest is not just beneficial to the bear. Agnieszka Gautier, on NASA's Earthdata webpage, notes that the Atchafalaya flood basin

[13] Maria Davidson et al., "Louisiana Black Bear Management Plan" (Baton Rouge, Louisiana: Louisiana Department of Wildlife and Fisheries, January 2015), 16.
[14] Lower Mississippi Valley Joint Venture Forest Resource Conservation Working Group, "Restoration, Management, and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat" (Vicksburg, Mississippi: Lower Mississippi Valley Joint Venture Forest Resource Conservation Working Group, 2007), 26.
[15] Atchafalaya National Heritage Area, "Atchafalaya Basin," Water Heritage, accessed April 18, 2020, https://www.atchafalaya.org/atchafalaya-basin.

"combines wetlands and river deltas that buffer against major catastrophes."[16] Thus, protection of the Louisiana black bear's preferred habitat also protects humans in the region.

Ecosystem services like this demonstrate the great value of biodiversity conservation to humans. As landscape planner and ecologist Nina-Marie Lister explains, "biological diversity is vital to ecosystems as the basis of resilience, and of the ability of an ecosystem to buffer itself from being pushed into another (potentially less desirable) state, and to regenerate itself following a systemic shift or other disturbance."[17] In other words, ensuring the flourishing of the bottomland hardwood forest ecosystem will make the ecosystem stronger, and therefore better able to adapt and regenerate than engineered structures like levees. Working with her firm, SCAPE, Kate Orff designs at the auspicious intersection of ecosystem services and wildlife ecology with projects like Oyster-tecture, which proposes structures along the Brooklyn shoreline that serve as both wavebreaks and oyster habitat.[18]

4.2 Behavioral Analysis and Life History

In order to properly design for the Louisiana black bear, one must first understand its behavior. Behavior, related to diet and yearly stages of life, is mapped seasonally in Figure 7. The Louisiana black bear is an opportunistic omnivore, meaning that it will mostly eat whatever is available to it, including both plants and animals.[19] For this reason, its diet varies throughout the year, and includes food items ranging from berries, to corn, to white-tailed deer. It will even rummage in human garbage for food, which, coupled with its aforementioned taste for corn, can lead to potential conflict with humans. With this in mind, the deliberate placing of native food sources, such as oaks and dewberries, is a key component in several of this project's design strategies.

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[16] Agnieszka Gautier, "A Tale of Two Rivers," Earthdata, October 11, 2013, https://earthdata.nasa.gov/learn/sensing-our-planet/a-tale-of-two-rivers/.
[17] Nina-Marie Lister, "Sustainable Large Parks: Ecological Design or Designer Ecology?," in *Large Parks*, ed. Julia Czerniak and George Hargreaves (New York: Princeton Architectural Press, 2007), 44.
[18] Kate Orff, *Toward an Urban Ecology*, 89-107.
[19] "Louisiana Black Bear," Southeast Region of the U.S. Fish and Wildlife Service, accessed April 14, 2020, https://www.fws.gov/southeast/wildlife/mammals/louisiana-black-bear/.

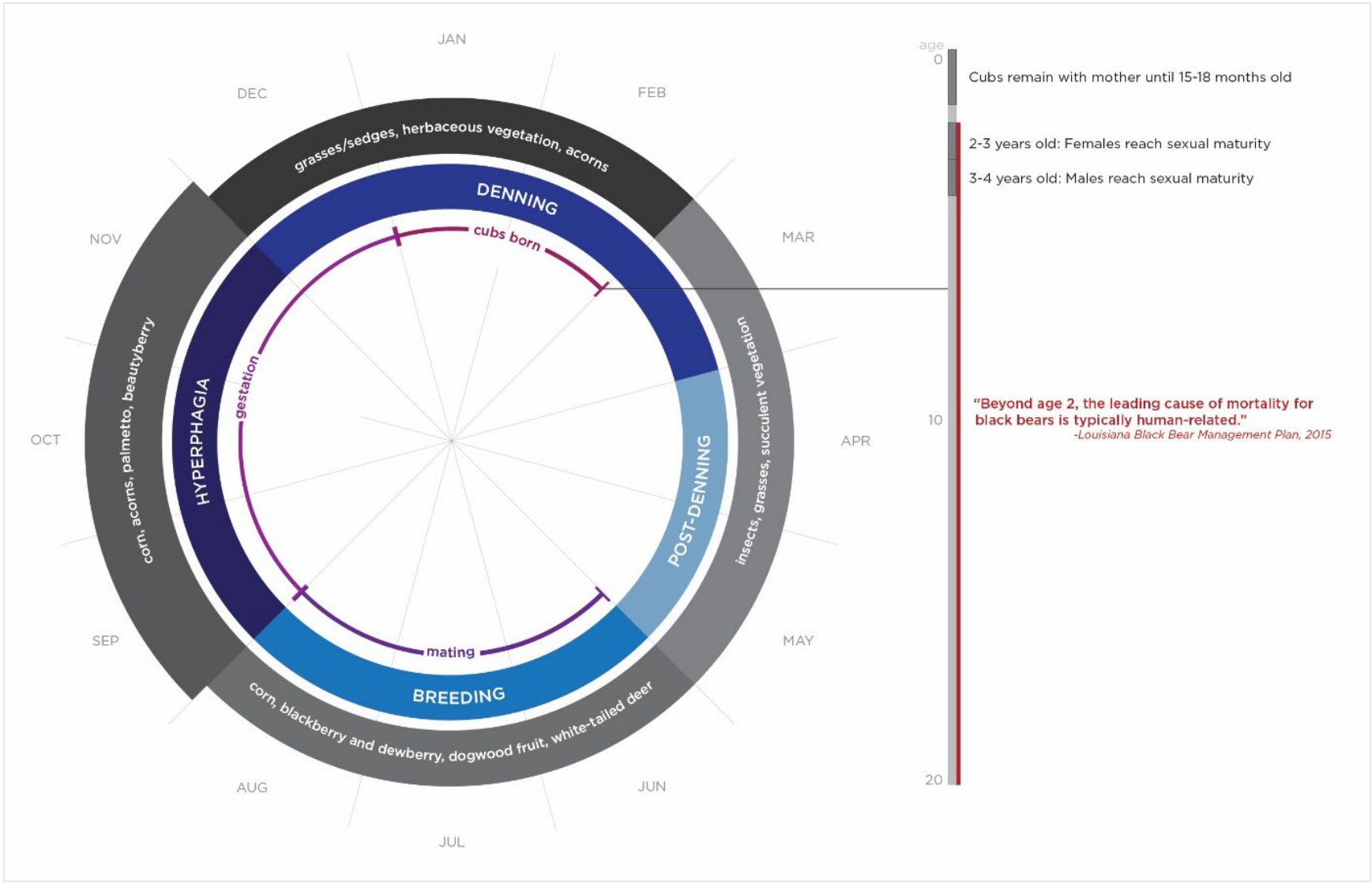

Figure 7. Seasonal Behavioral Analysis and Life History of the Louisiana Black Bear

Knowledge of bears' yearly stages is also key in understanding their behavior. It can tell us when they are most active (breeding season, June-August), when they are eating the most (hyperphagia, September-November), and when they are least active (denning, December-February). Although Louisiana black bears do not hibernate like other subspecies of American black bears do, their denning season is similar, featuring greatly reduced activity. It is during denning season that cubs are born, and these cubs will remain with their mother for about a year and a half.[20] This information heavily impacted design considerations. According to one study, female bears, though physically able to cross rivers, may refrain from doing so when accompanied by their cubs.[21] This can limit the movement of a significant portion of the species, and may prove especially problematic if climate change forces the species to emigrate to a more suitable climate. River bridges are thus heavily featured in the design catalog.

Additionally, examination of the life history of the Louisiana black bear reveals that "beyond age 2, the leading cause of mortality for black bears is typically human-related."[22] The leading cause of Louisiana black bear mortality is vehicle collisions,[23] making both barriers to roads and introduction of safe road-crossing structures important features of the design catalog as well.

4.3 Habitat Analysis

Although bottomland hardwood forest is the Louisiana black bear's *preferred* habitat, it is not its only suitable habitat. Arranged in Figure 8 are other habitat types that the species typically occupies: marshes, wooded spoil levees, and agricultural fields. As the Louisiana black bear is a human-avoiding animal, habitat types that have lower levels of human disturbance are preferred. Agricultural fields, though they include high levels of human disturbance, are likely occupied due to their sheer ubiquity in the region and their abundance of food for the bears.

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[20] Louisiana Department of Wildlife and Fisheries, "Louisiana Black Bear," accessed April 18, 2020, https://www.wlf.louisiana.gov/species/detail/louisiana-black-bear.
[21] Thomas H White, Jr. et al., "Influence of Mississippi Alluvial Valley Rivers on Black Bear Movements and Dispersal: Implications for Louisiana Black Bear Recovery," Biological Conservation 95, no. 3 (October 2000): 323–31.
[22] Davidson et al., "Louisiana Black Bear Management Plan," 15.
[23] Ibid.

Agricultural fields are not ideal habitats, however, as they feature high levels of human disturbance and low levels of ecological value overall. They also create conflict between bears and humans. Designs in the project catalog thus seek to provide plenty of alternative food sources and some living barriers to agricultural fields.

Figure 8. Analysis of Existing Louisiana Black Bear Habitats, Arranged by Level of Human Disturbance

4.4 Journalism Analysis

A survey of local news helped to better understand the relationship of local communities with the Louisiana black bear. Displayed in Figure 9, some of the most important takeaways from this survey were that bears enter human spaces most frequently during breeding season and that public opinion, at least as expressed by local media sources, is overwhelmingly neutral rather than positive or negative. Knowing when human-bear conflicts happen is key to understanding how to design in order to avoid those conflicts. Understanding public opinion is important in assessing how accepting humans will be to a bear-focused design project happening in their backyard.

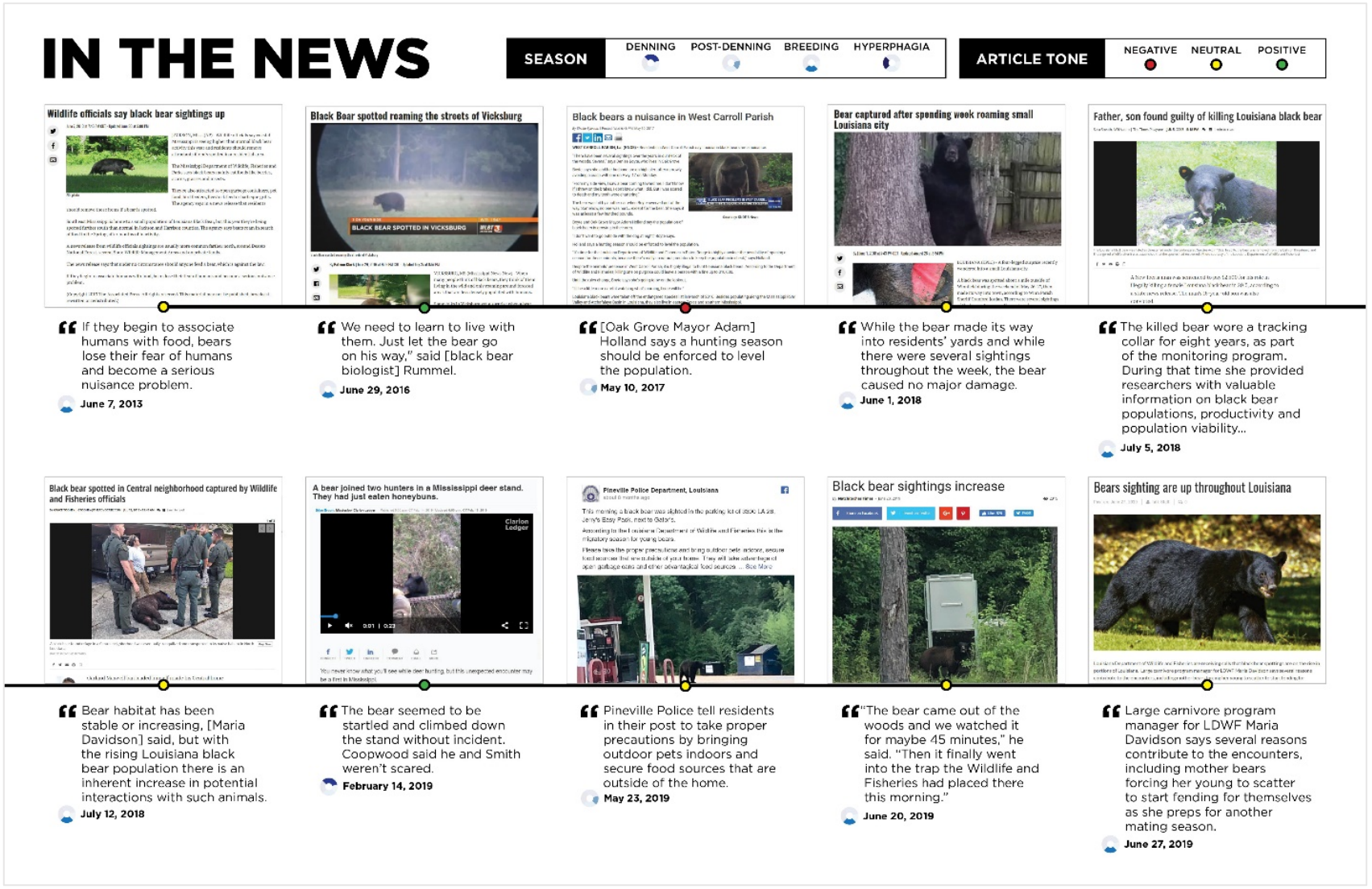

Figure 9. Analysis of Local News Articles Related to the Louisiana Black Bear

Because bears are large mammalian predators, getting the public on board with projects designed specifically for bears can be difficult. Bringing the bear into public awareness can be met with resistance due to society's fear of a potentially dangerous animal. Though the Louisiana black bear might already be in the area, knowledge of its presence may cause alarm for some. Because the bear is human-avoidant, however, keeping humans and bears apart physically is actually beneficial for both species. One goal of this design project is thus to create a greater awareness of the importance of the bear while acknowledging and designing for as much physical separation as possible.

4.5 Historical Analysis

The Louisiana black bear plays an important role not only ecologically, but culturally as well. In 1902, it was a Louisiana black bear that President Theodore Roosevelt refused to shoot on a hunting trip, prompting the creation of the iconic teddy bear toy and adding to President Roosevelt's legacy of conservation.[24] Already linked to the idea of conservation, the subspecies would also emerge later as a more controversial subject in the movement.

Before European colonization in the seventeenth century, the Louisiana black bear population was estimated to be around 80,000.[25] In the late eighteenth and early nineteenth centuries, the invention of the cotton gin and the introduction of ribbon cane (sugar cane especially suitable to the state's climate) began to change the Louisiana landscape.[26] Fields of sugarcane and cotton make up a significant portion of Louisiana landscape to this day, likely in places that used to provide much more suitable habitat to the black bear. The industrial cypress lumbering era, beginning in 1890 and lasting through 1956,[27] had a similarly detrimental effect on Louisiana black bear habitat, removing a prominent bottomland hardwood forest species

[24] U.S. Fish and Wildlife Service, "About the Refuge - Theodore Roosevelt,", accessed April 14, 2020, https://www.fws.gov/refuge/Theodore_Roosevelt/about.html.
[25] Jusdanis, "The Bear That Went from Presidential Namesake to Political Pawn."
[26] Louisiana Department of Culture, Recreation and Tourism, "Antebellum Louisiana: Agrarian Life," Louisiana State Museum, accessed April 14, 2020, https://DCRT-MAIN/louisiana-state-museum/online-exhibits/the-cabildo/antebellum-louisiana-agrarian-life/index.
[27] Ervin Mancil, "An Historical Geography of Industrial Cypress Lumbering in Louisiana. (Volumes I and II)." (Louisiana State University, 1972), iii, 85, https://digitalcommons.lsu.edu/gradschool_disstheses/2296.

and a favorite denning tree of the bear (*Taxodium distichum*). At the end of this era, the Louisiana black bear population was estimated to be down to 80 to 120.[28]

Coinciding with the advent of more widespread awareness of environmental issues in the 1960s, efforts to aid the Louisiana black bear began with a translocation of 161 black bears from Minnesota between 1964 and 1967.[29] In 1973 the Endangered Species Act was passed, and in 1992 the Louisiana black bear was recognized as an endangered species and given protection under this act. By 2016, less than two decades later, the subspecies was removed from the list, with its estimated population up to around 750.[30] This decision was not without controversy, however. In 2018, a coalition of conservation groups, including the Sierra Club, filed a lawsuit against the Secretary of the U.S. Department of the Interior and the director of the U.S. Fish and Wildlife Service for the bear to regain protection under the Endangered Species Act, claiming that its removal from protection was an error that could prove fatal for the subspecies.[31]

This controversy suggests that the Louisiana black bear is still a threatened population, and that measures beyond national law might be better avenues for supporting the subspecies in practice. These issues will be considered in Chapter 5.4.

[28] Jusdanis, "The Bear That Went from Presidential Namesake to Political Pawn."
[29] Caitlin M. Glymph, "Spatially Explicit Model Of Areas Between Suitable Black Bear Habitat In East Texas And Black Bear Populations In Louisiana, Arkansas, And Oklahoma" (M.S. thesis, Stephen F. Austin State University, 2017), 2.
[30] Jusdanis, "The Bear That Went from Presidential Namesake to Political Pawn."
[31] Sierra Club, "Louisiana Black Bear Lawsuit," July 5, 2018, https://www.sierraclub.org/louisiana/louisiana-black-bear-lawsuit.

CHAPTER 5: DESIGN PROPOSAL

5.1 Design Interventions Catalog

The culmination of this thesis project is a catalog of fifty design interventions that facilitate (1) the connectivity of Louisiana black bear subpopulations, (2) climate-related migration of the subspecies, and (3) more amicable coexistence of bears and humans. This catalog is represented in full in Figure 10, with design interventions arranged in terms of location: river (*fig. 11*), agricultural field (*fig. 12*), river edge (*fig. 13*), roadway (*fig. 14*), and miscellaneous locations (*fig. 15*). The river and roadway locations were selected because both prevent bear movement, either via fatality or unwillingness to cross. Agricultural fields not only represent a ubiquitous spatial condition in the region, but they are somewhere that Louisiana black bears can already be found, but not where they are necessarily desired. Designs here allow and encourage the animal to continue moving through the space with as little disturbance to crops as possible. The edge of the river was selected because the batture (the area between the levee and the river) is already a space frequently used by bears[32] for passage, but one that could be made even more suitable through deliberate design.

These design interventions are created for a range of typical spatial conditions and represent a collection of prototype options to be placed throughout the study area (*fig. 16*). Options are intended to be selected, combined, and built in response to specific site conditions. Each design intervention has a corresponding code, and these codes, represented in their corresponding location color (found in the top left corners of *fig. 11-15*), are used on design plans to locate which design from the catalog is being used.

[32] White, Jr. et al., "Influence of Mississippi Alluvial Valley Rivers on Black Bear Movements and Dispersal: Implications for Louisiana Black Bear Recovery," 328.

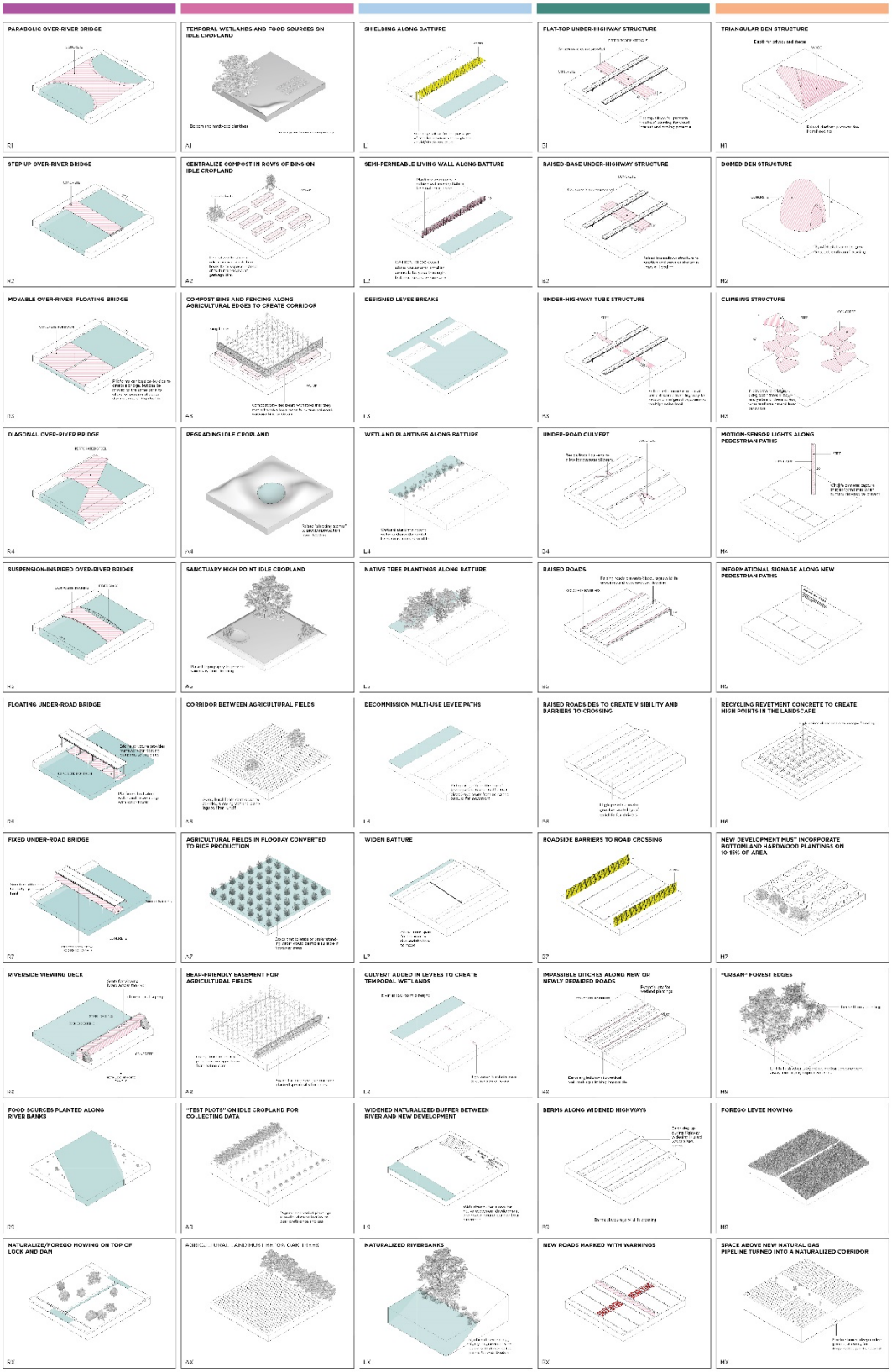

Figure 10. Design Interventions - Full Catalog

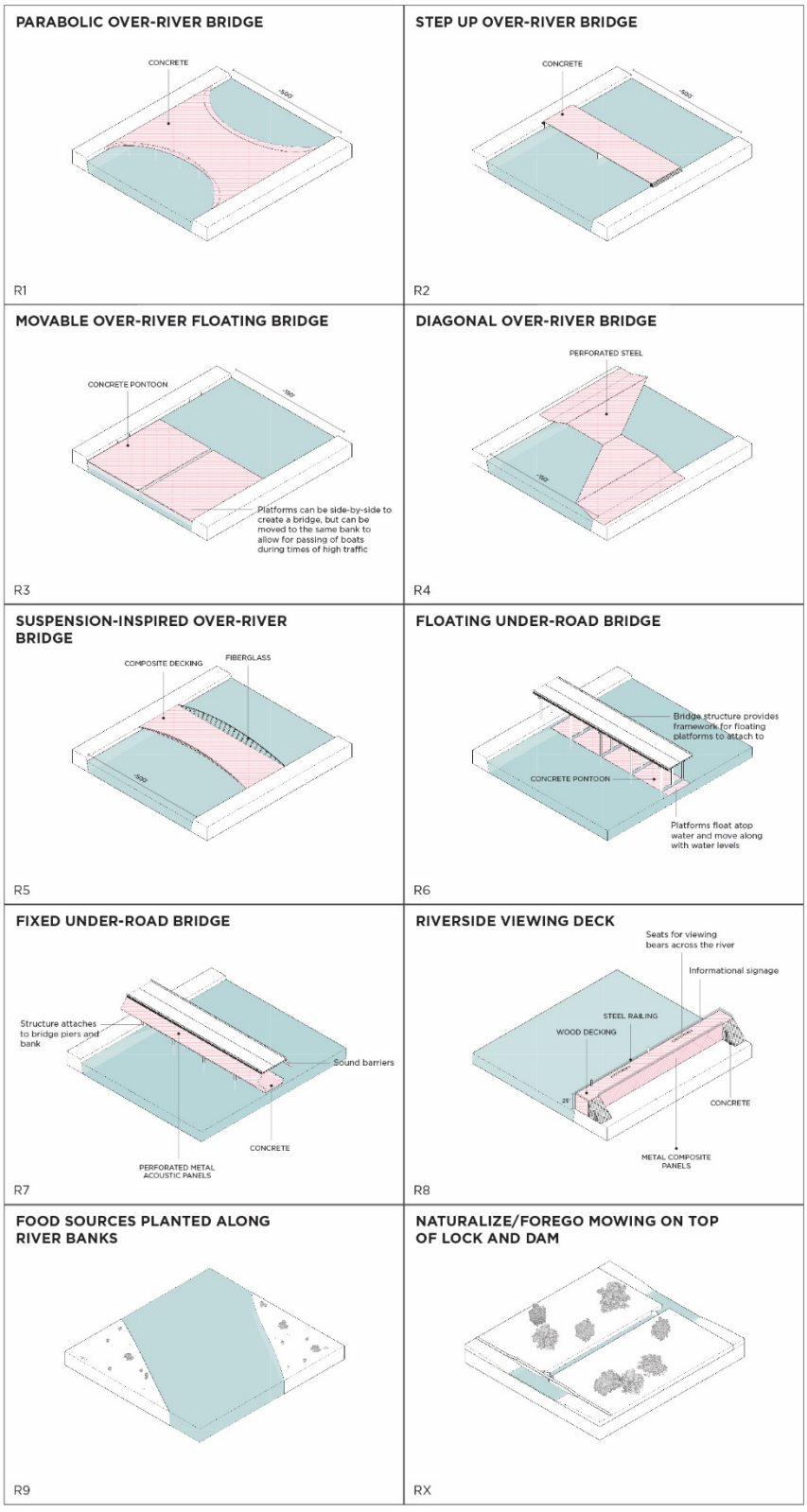

Figure 11. Design Interventions – River

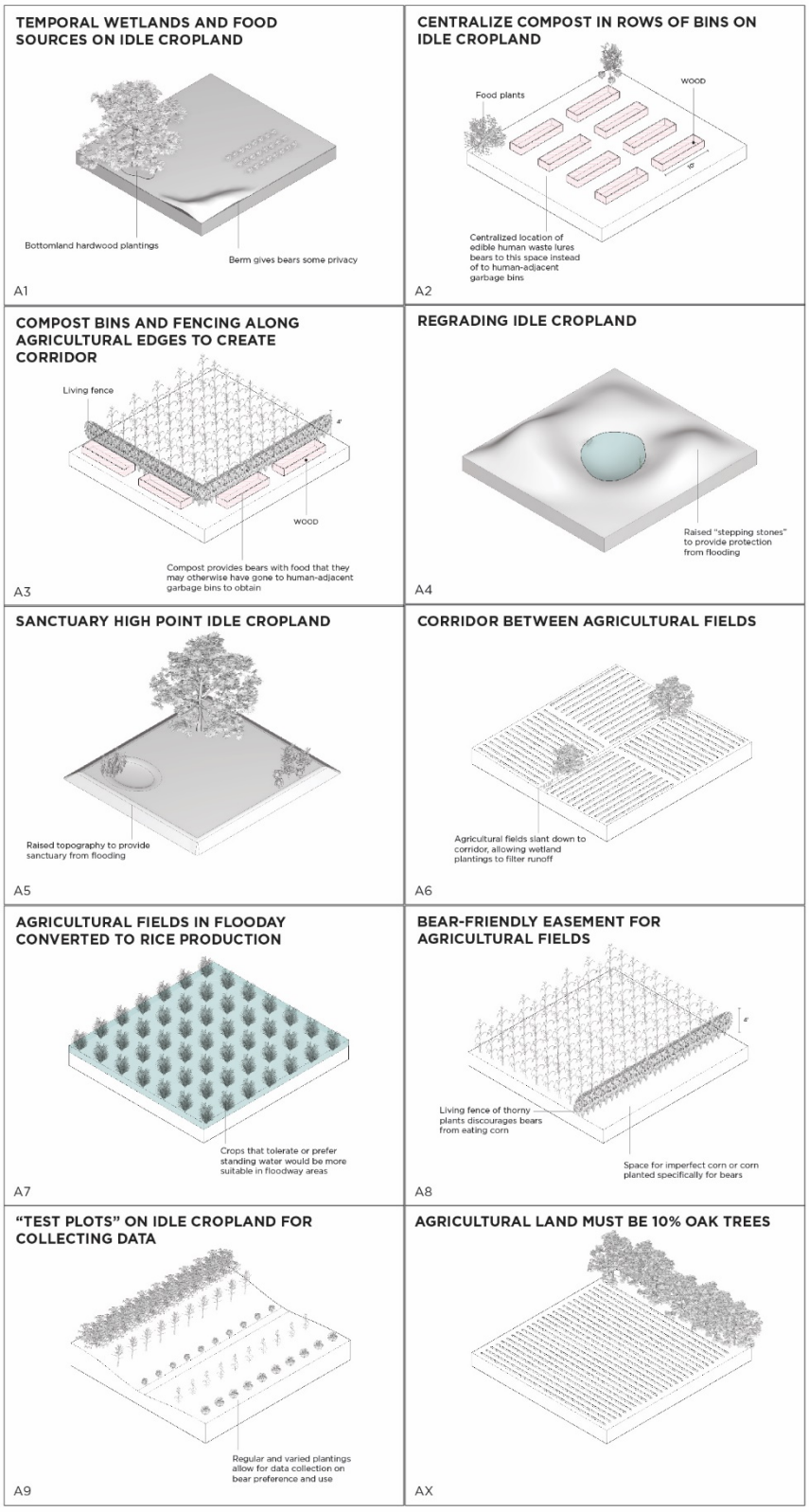

Figure 12. Design Interventions – Agricultural Field

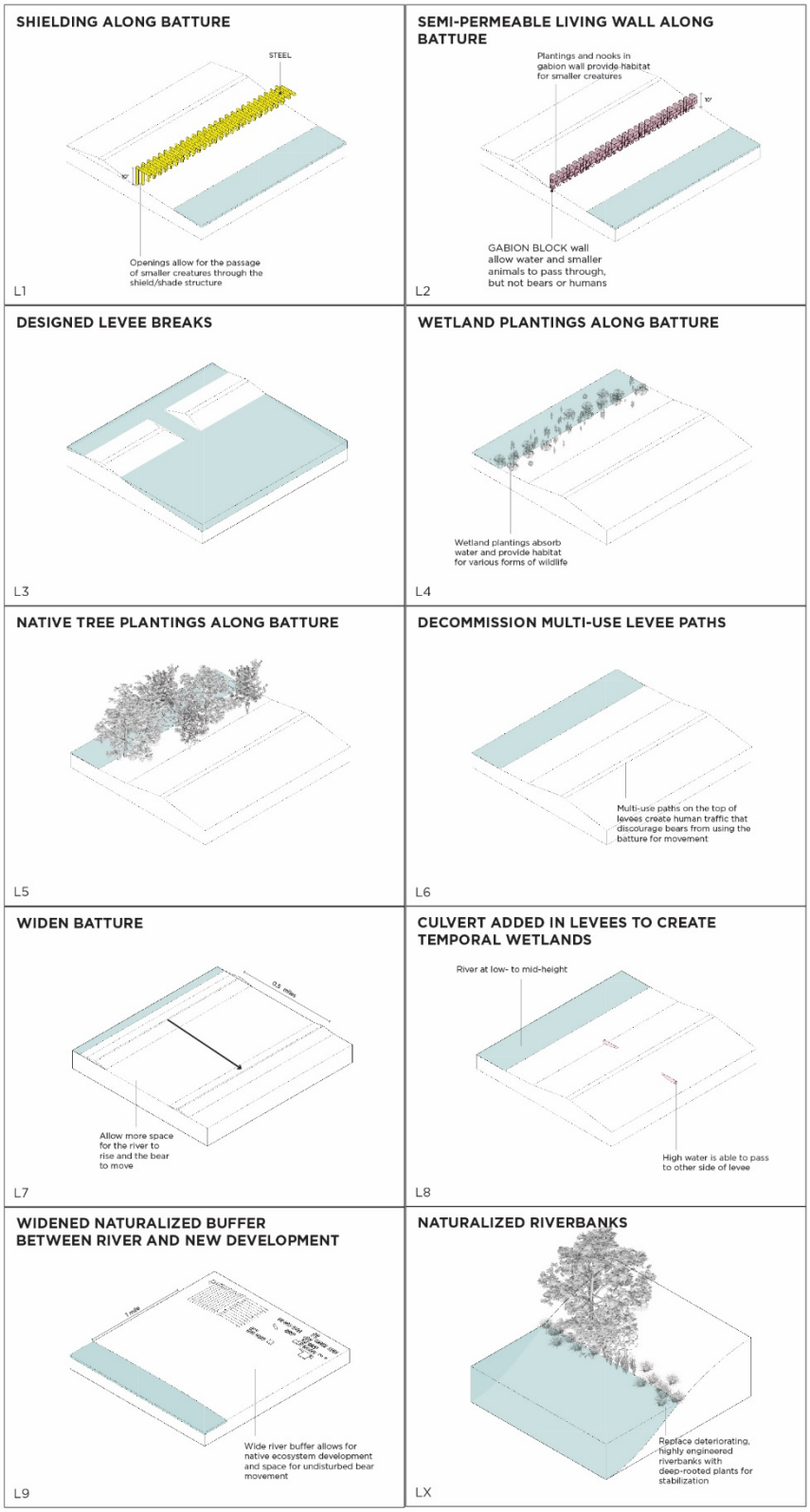

Figure 13. Design Interventions - River Edge

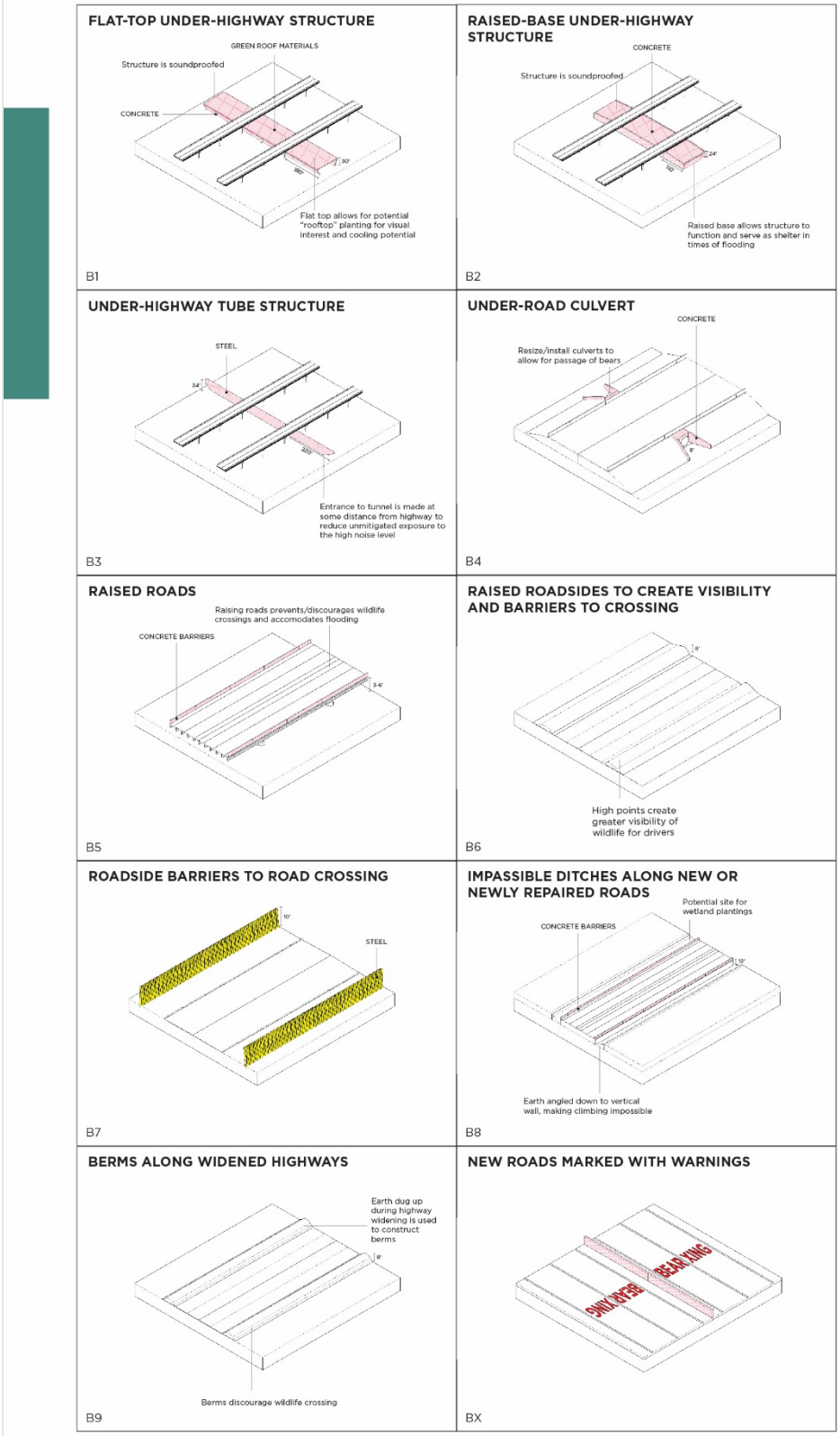

Figure 14. Design Interventions - Roadway

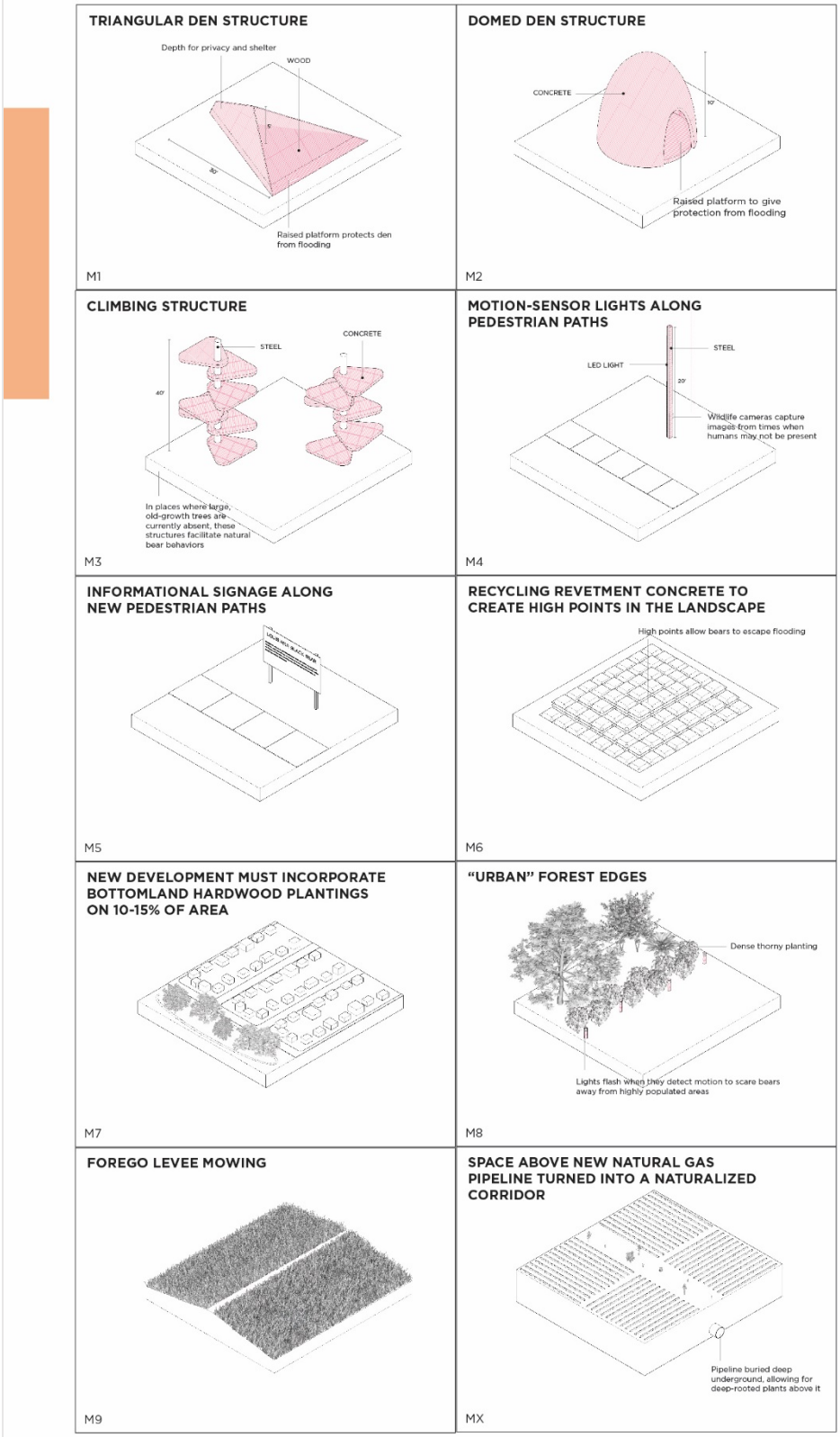

Figure 15. Design Interventions - Miscellaneous

5.2 Regional Design Areas

In order to see where these design interventions could be placed most effectively, a map of the area was carefully examined, considering the four subpopulations of Louisiana black bears[33] and anything that could help or hinder their movement. Satellite images, the Louisiana Department of Transportation and Development's list of infrastructural projects to be let, the United States Department of Agriculture's CropScape maps, levee maps, Google Street View, and the locations of rivers, roads, urban areas, and conservation lands were all studied and compared to discern the spaces presenting opportunity for meaningful design intervention. Based on this examination, three regional design areas were selected (*fig. 16b*) where groups of design interventions could prove extremely useful based on existing spatial conditions.

[33] Joseph D. Clark et al., "Connectivity among Subpopulations of Louisiana Black Bears as Estimated by a Step Selection Function: Connectivity Among Louisiana Black Bear Subpopulations," The Journal of Wildlife Management 79, no. 8 (November 2015): 1349, https://doi.org/10.1002/jwmg.955.

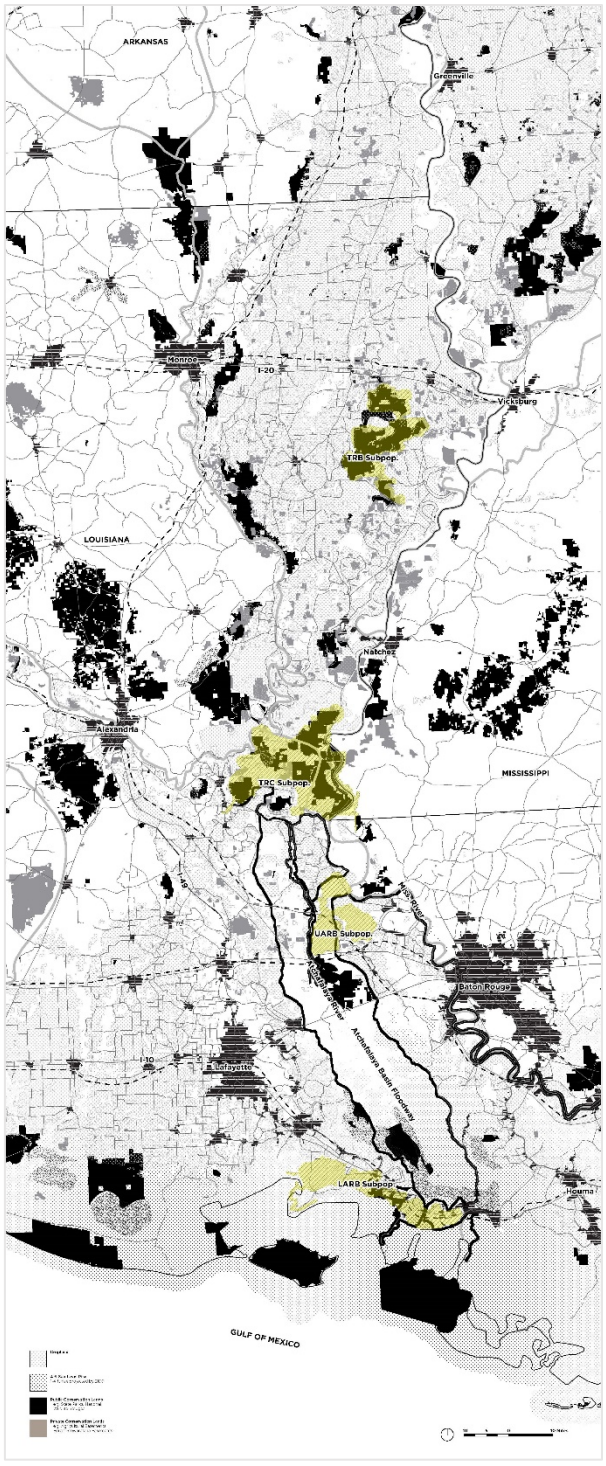

Figure 16a. Study Area for Potential Design Intervention (Data Sources in Bibliography)

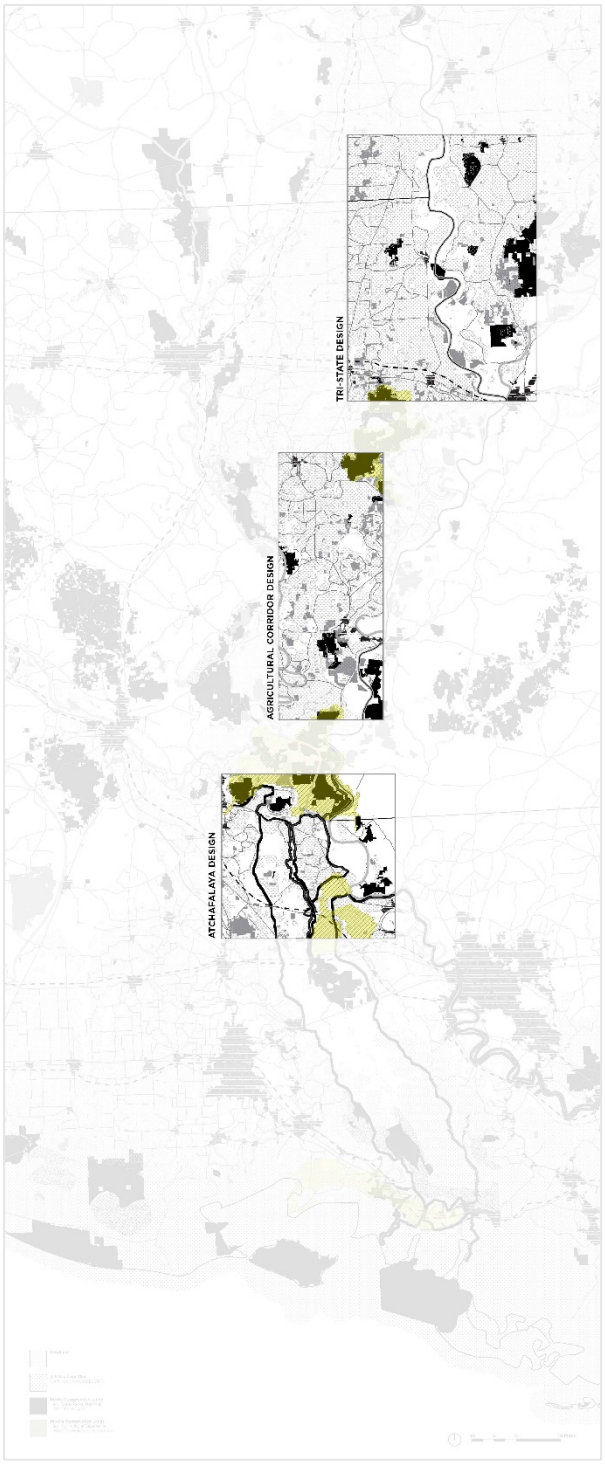

Figure 16b. Location of Regional Design Areas

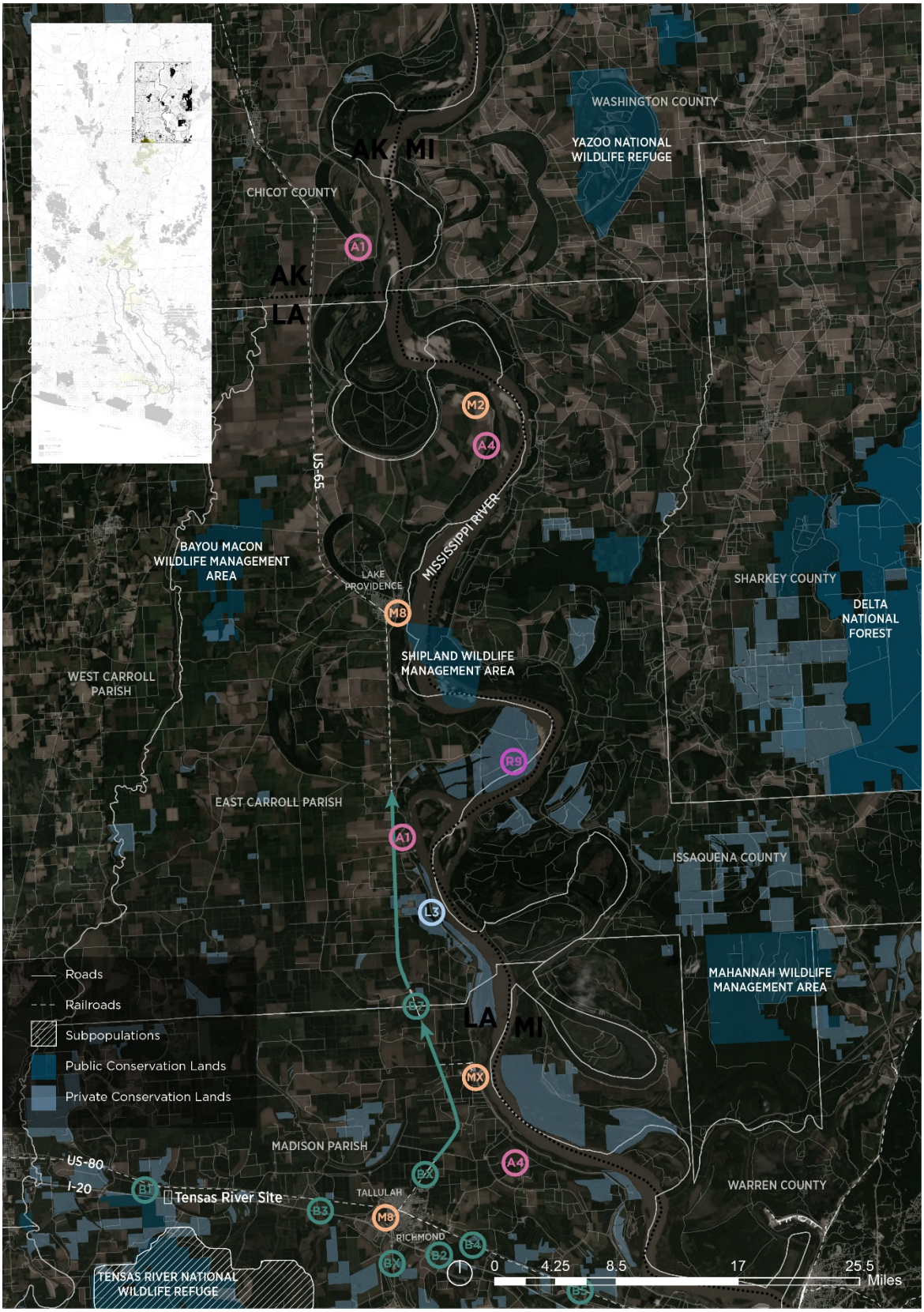

Figure 17. Tri-State Design Area, Located North of the Tensas River Basin Subpopulation. Many roadway design interventions are needed in this area, and other interventions are placed along the Mississippi River to encourage that movement path.

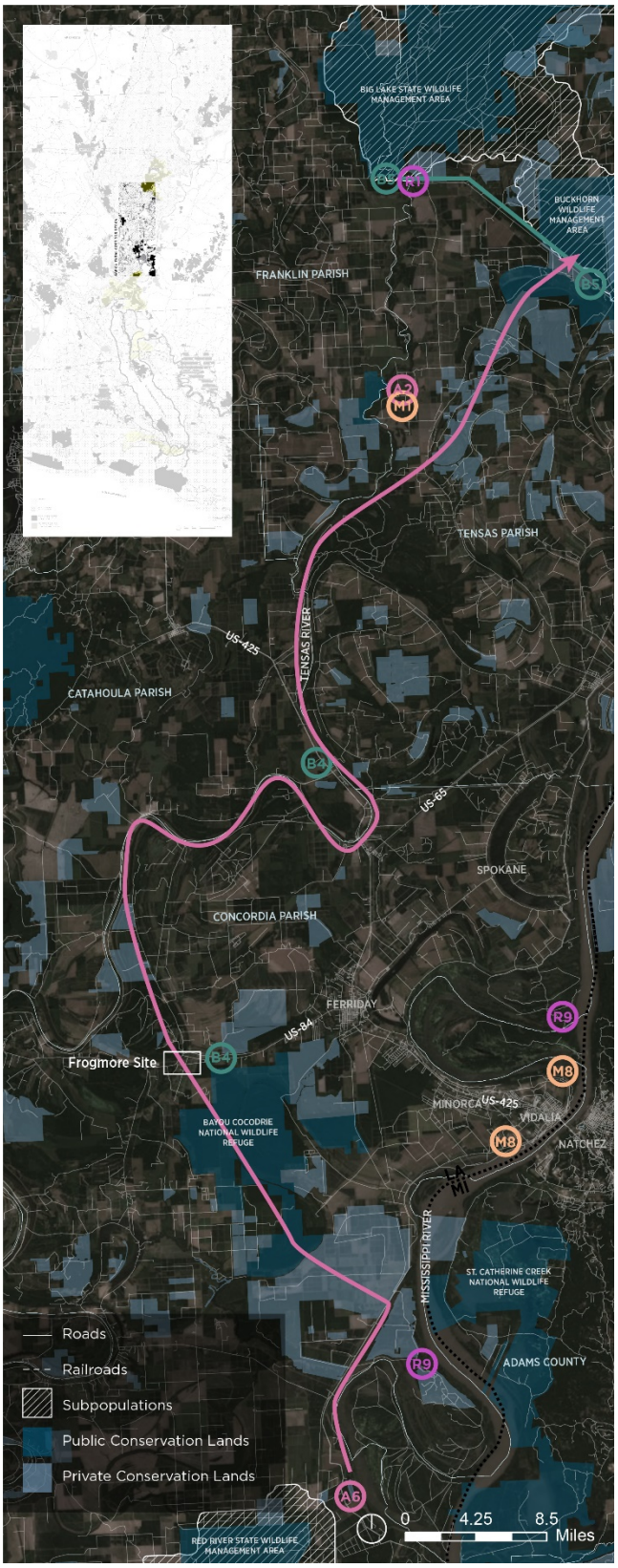

Figure 18. Agricultural Corridor Design Area, Located between the Three Rivers Complex and Tensas River Basin Subpopulations. This area is heavily covered in agricultural fields. The proposed corridor, shown as a pink line, aims to connect the two subpopulations by connecting by the shortest distance existing conservation areas and natural river corridors.

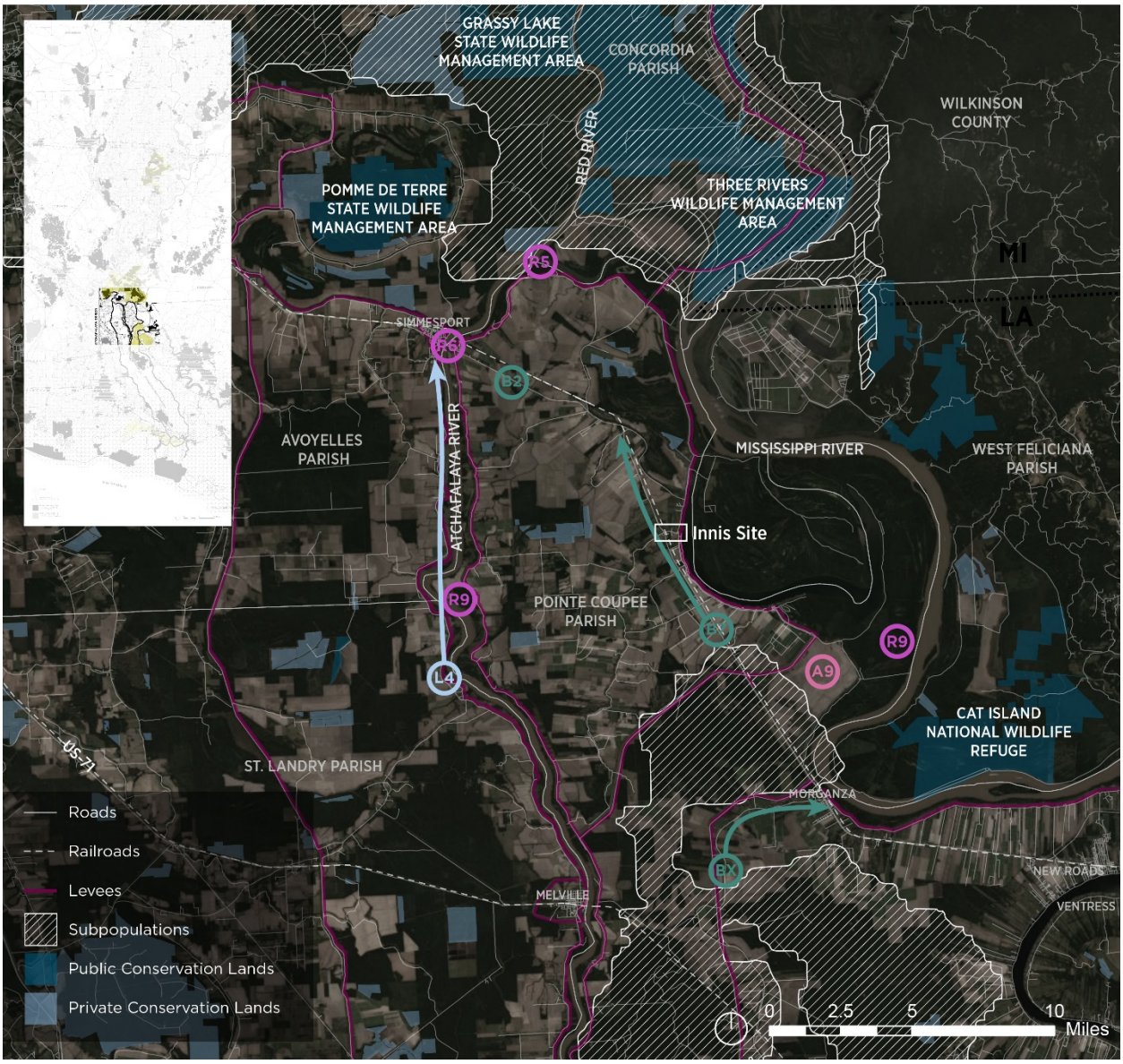

Figure 19. Atchafalaya Design Area, Located Between the Upper Atchafalaya River Basin and Three Rivers Complex Subpopulations. This design area takes advantage of battures (areas between the river and levees) as current corridors of movement, and aims to make these areas even more suitable while also adding key river and road crossings to ensure the safety of travelling bears.

5.3 Prototypical Site Designs

The final stage of design involves implementing these design interventions in detail. One detailed site plan was created for each regional design area (*fig. 20-22*) in order to show how prototypes might touch ground in different real world spatial conditions. These sites were selected with consideration for: variety of site conditions (river, cropland, roadways, etc.), presence of potential conflict between two conflict-free areas (higher-quality habitat patches),

and, in one case, location of planned infrastructural work to which designed interventions could easily be added.

The Tensas River Site Plan (*fig. 20*) is located in the Tri-State Design Area where the Tensas River crosses under Interstate 20. This site is just north of the Tensas River National Wildlife Refuge. The aim of this site plan is to lead to bear to cross the interstate by going under it, along the Tensas River, rather than across it. For this reason, a roadside barrier is placed along the south side of the highway, to reduce mortality due to vehicular collisions as the bears move northward. The Tensas River Basin subpopulation, found largely in the Tensas River National Wildlife Refuge, is currently the northernmost subpopulation, but the bear's historical range goes further north, and climate change may force the subspecies to migrate northward for more suitable climates. In addition to the roadside barriers, an under-highway structure is placed where the Tensas crosses under the highway. This concrete structure extends about 250 feet past the edge of the highway, sheltering bears from the noise of the cars above and allowing bears to walk along the water's edge without much disturbance.

The Frogmore Site Plan (*fig. 21*), located in the Agricultural Corridor Design Area near the Frogmore Cotton Plantation, consists of a cottonfield situated between the Bayou Cocodrie National Wildlife Refuge and a heavily wooded area adjacent to the Tensas River. Louisiana black bear movement would presumably be from the wildlife refuge, in the southeast area of the site plan, to the Tensas River in the northwest. The path is designed to start as an agricultural corridor planted with native bottomland hardwood forest species, with the bear then crossing a road by using a large underground culvert beginning in an existing marshy area, and finally using a concrete bridge to cross the Brushy Bayou and head towards the woody corridor along the Tensas River.

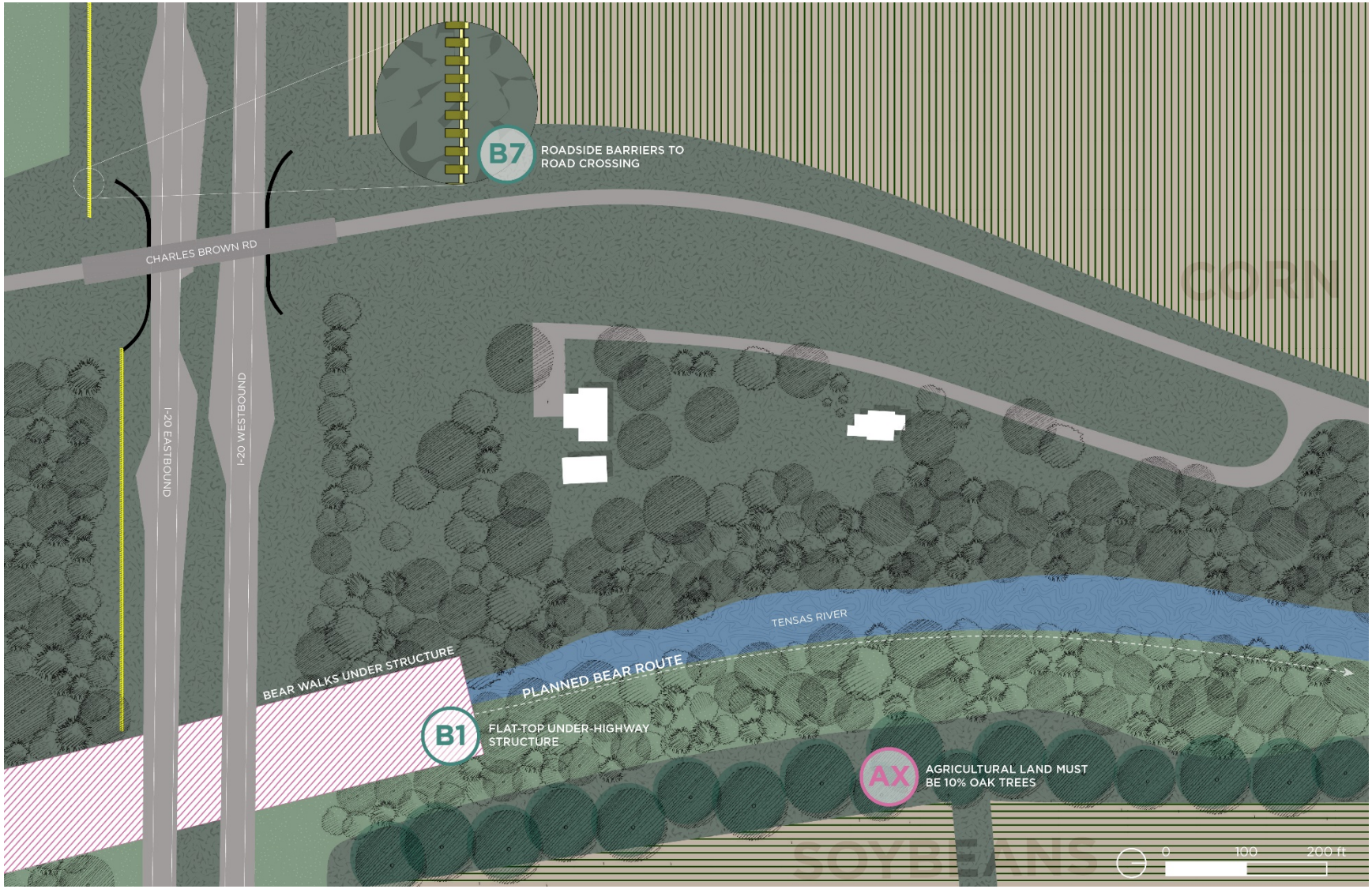

Figure 20. Tensas River Site Plan

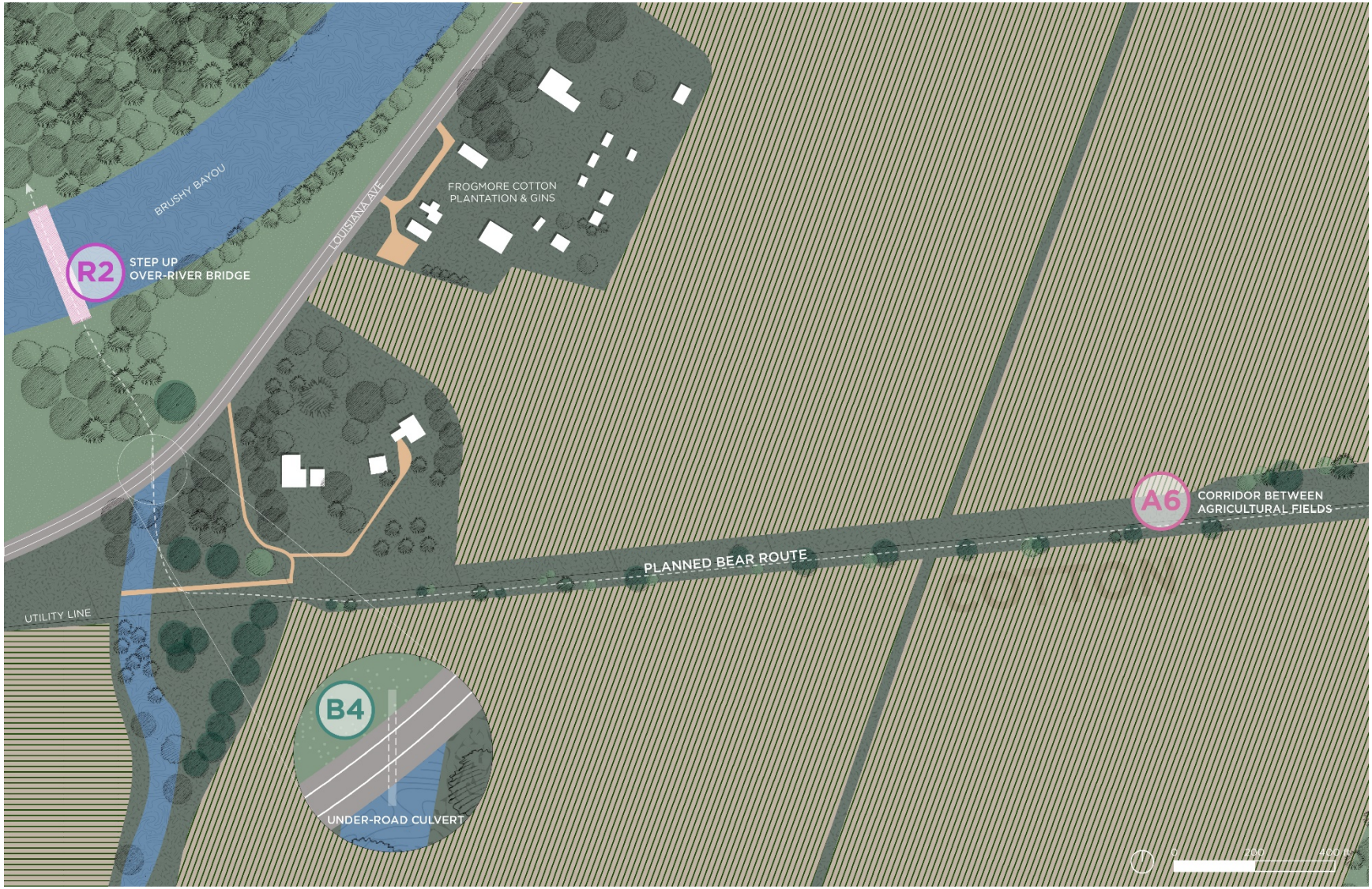

Figure 21. Frogmore Site Plan

The Innis Site Plan (*fig. 22*) is located in the Atchafalaya Design Area near the Innis unincorporated community. This site is north of the Upper Atchafalaya River Basin subpopulation and along the Raccourci Old River, an old pathway of the Mississippi. The Louisiana Department of Transportation & Development is planning to stabilize and overlay the asphalt on LA-417 between LA-1 and LA-418[34], making this site at the intersection of LA-1 and LA-217 an opportunity for added infrastructure improvements, such as the addition of "BEAR XING" paint on the road. Raising a section of LA-1 to an elevation of about six feet above ground level, just east of a wooded area on the western side of the site, would not only allow bears to cross under the road and therefore avoid collisions, but could also function as a safeguard against the road flooding, due to its proximity to the river. Decommissioning any use of the path along the top of the levee and foregoing levee mowing would also create a more livable environment for the bear.

In addition to detailed site plans, perspective images (representations of views from the ground level and bird's eye views) were created to provide a more instinctive visual for key stakeholders to understand what the end-results might look like (*fig. 23-25*). In a photorealistic way, these images depict typical conditions in the region (agricultural field, river, and batture/levee) and demonstrate what some of the interventions from the design catalog could look like. These images focus on the bear's breeding and hyperphagia seasons, our summer and fall, as these are when the bear is most active and most likely to be on the move.

[34] Louisiana Department of Transportation & Development, "Projects to be let," http://wwwapps.dotd.la.gov/engineering/lettings/lets8230.aspx

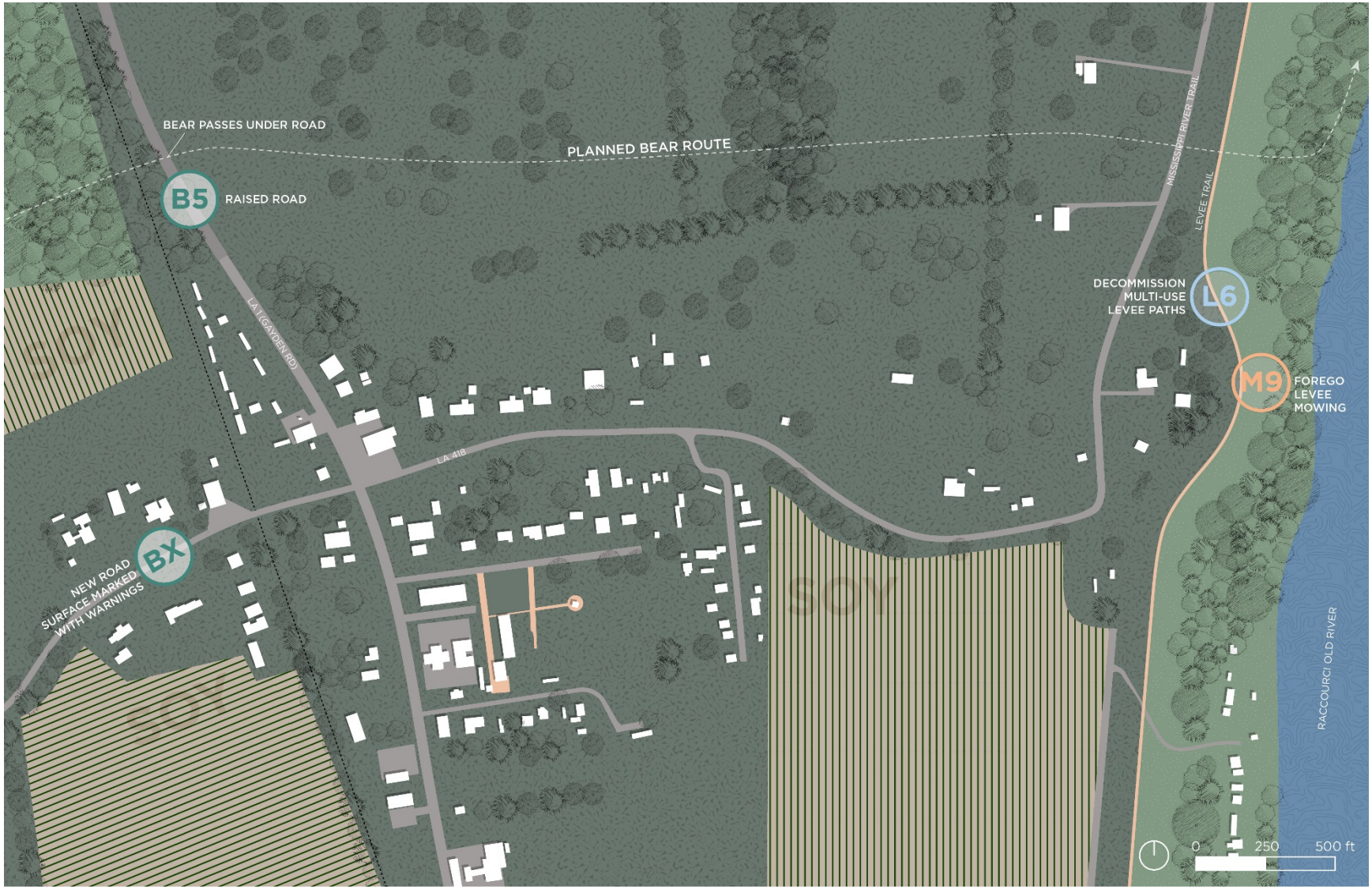

Figure 22. Innis Site Plan

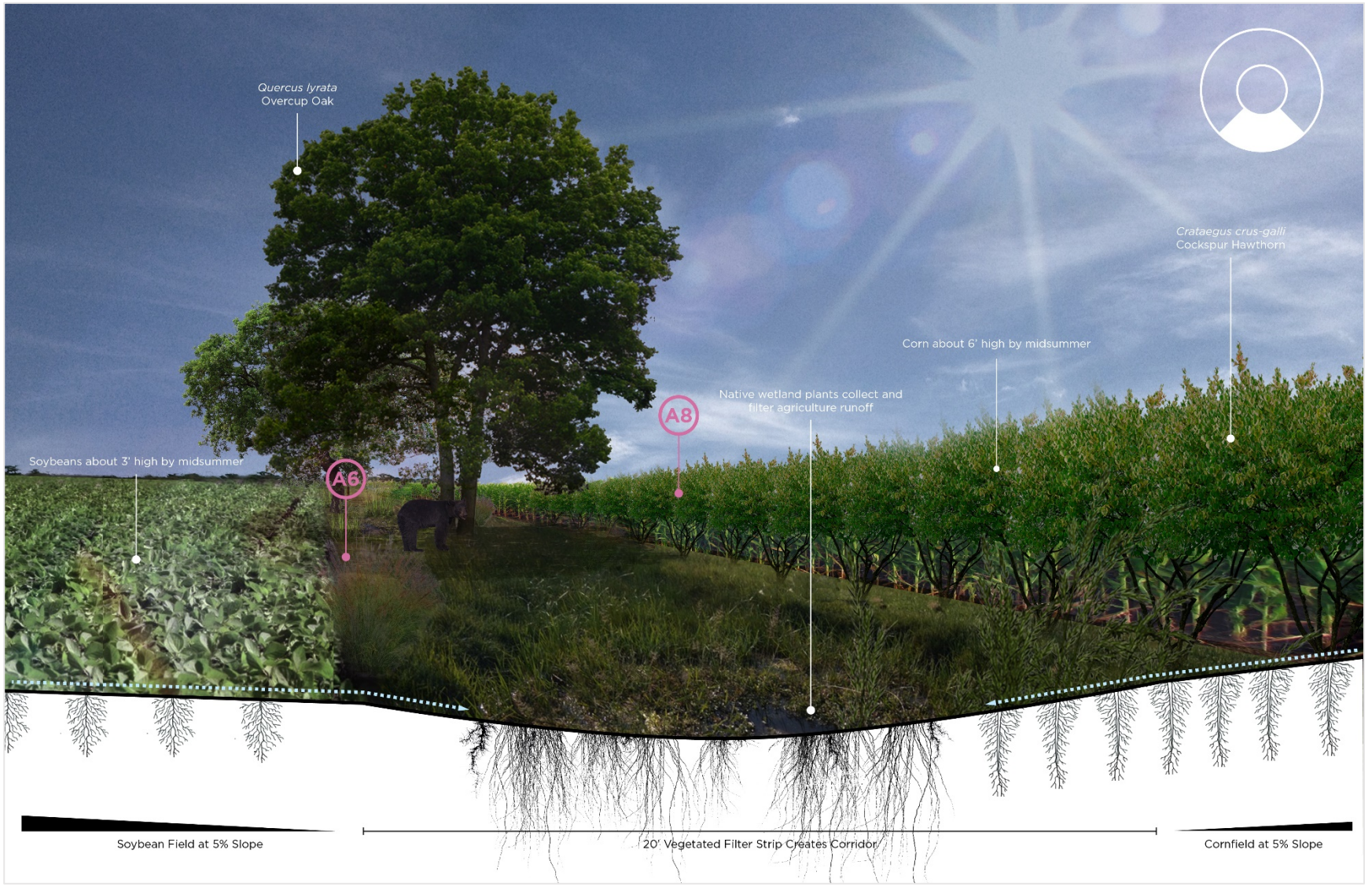

Figure 23. Perspective of Agricultural Corridor with Living Fence of Cockspur Hawthorn, Breeding Season

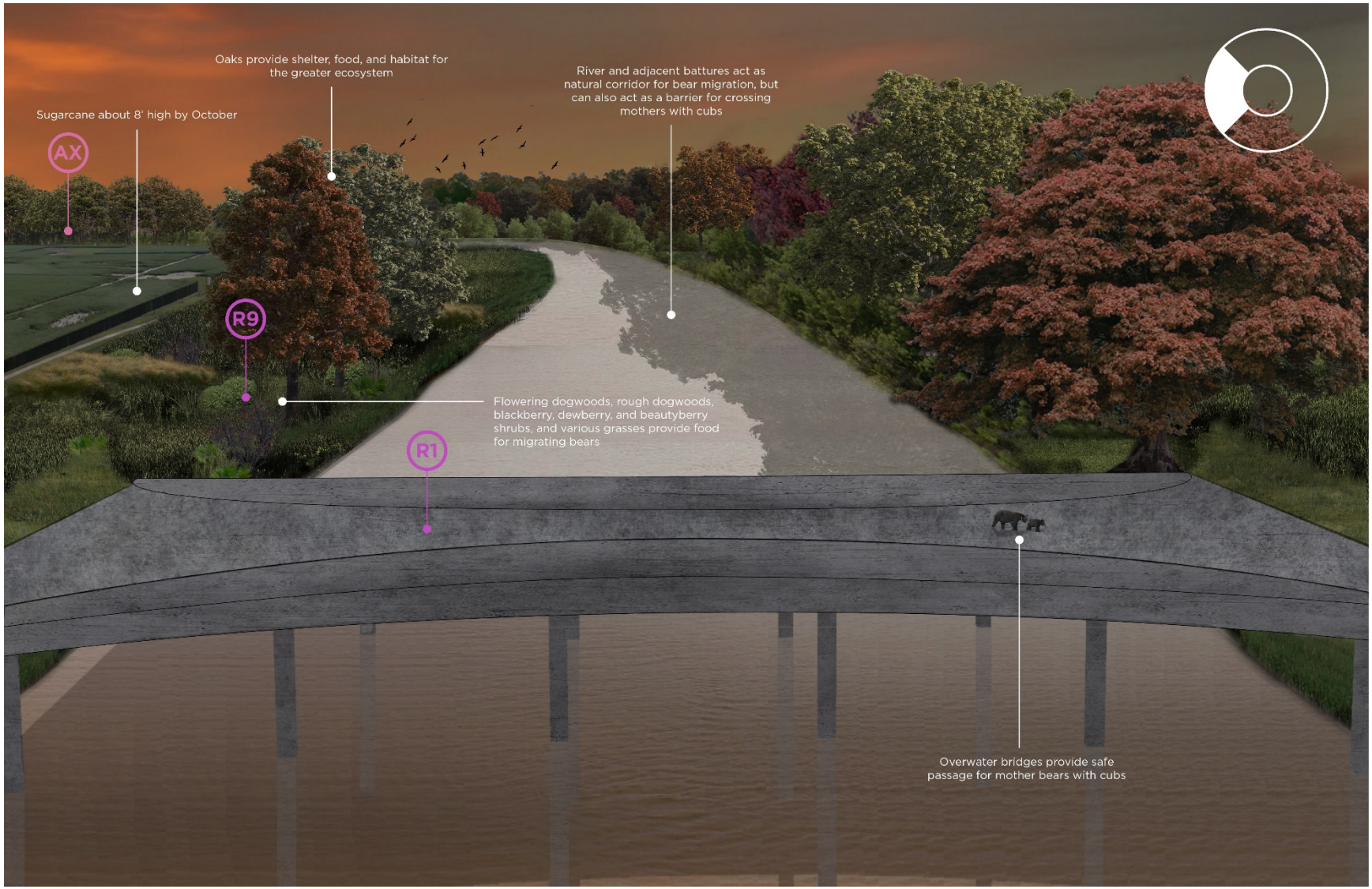

Figure 24. Perspective of Bridge Across River, Hyperphagia Season

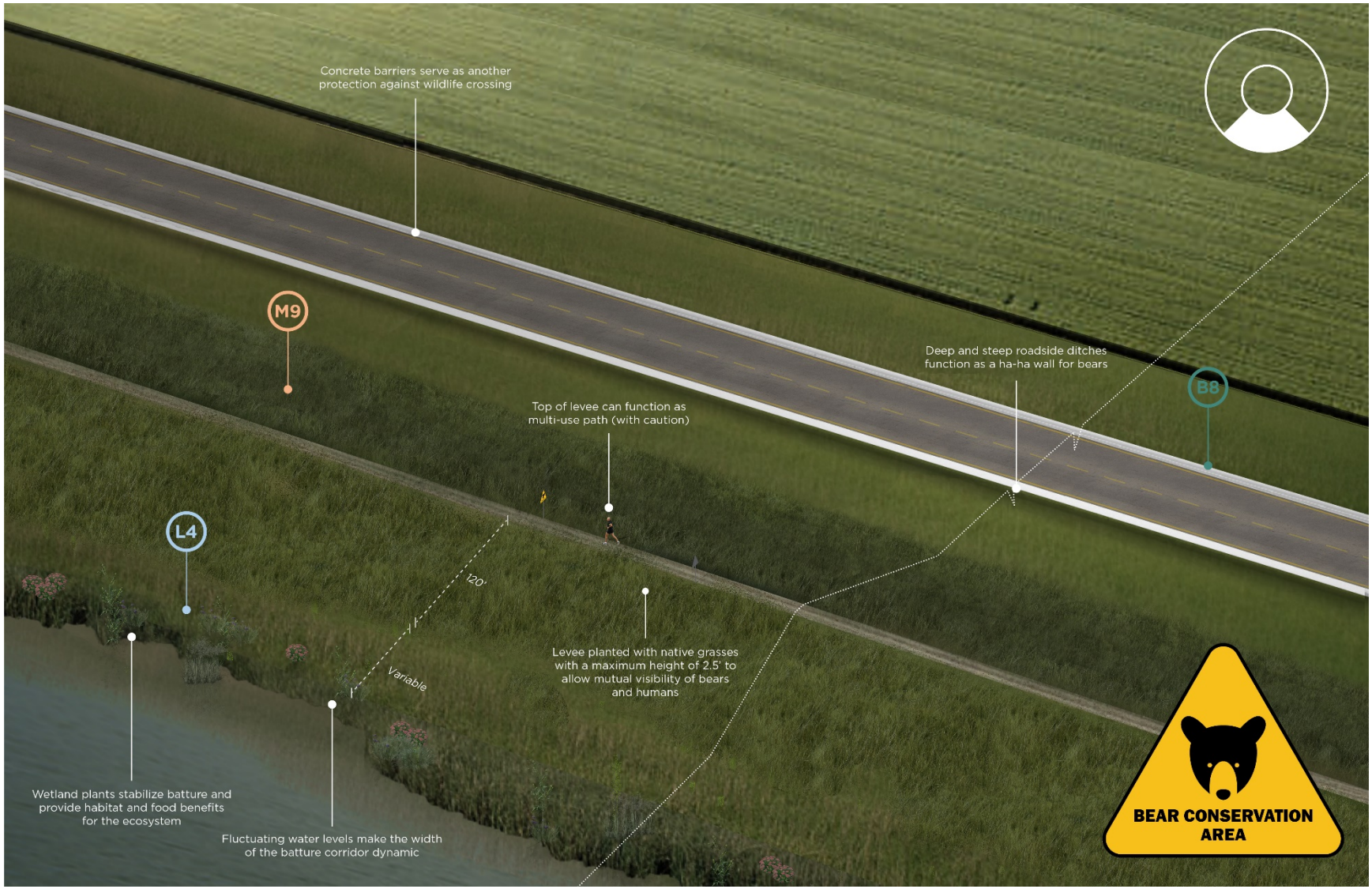

Figure 25. Perspective of Wetland Batture and Impassible Ditches Along Road, Breeding Season

5.4 Packaging Proposals for Implementation

As mentioned earlier, the status of the Louisiana black bear is in contention. Though it once was protected under the Endangered Species Act, it is currently delisted, meaning that any aid the subspecies was receiving under that act, legal, monetary, or otherwise, is no longer expected. Although various conservation groups are working to relist the bear, there are also alternative avenues to explore for ways to support the survival of the Louisiana black bear. Working with state departments, such as the Louisiana Department of Transportation & Development (LDOT) and the Louisiana Department of Wildlife and Fisheries (LDWF), these designs could be added to existing efforts and construction projects to gradually build a more bear-friendly environment. Packaging design proposals in a way that gives decision-makers a very clear vision and guide, as well as strong justification for implementation, is the final key to this thesis project.

Thus, the final component of this proposal is a small handbook for decision-makers. The handbook would include information on: estimated costs, materials, dimensions, and construction documents for each design intervention; a list of plant species most suitable for Louisiana black bear habitat; a brief description of the bottomland hardwood forest and its potential for providing ecosystem services; and maps of regions where the Louisiana black bear is found and what design interventions it might need in that region. Although the goal of the project is the conservation of the bear, the handbook must be developed with human benefits in mind in order to garner support and therefore resources. To this end, the design prototypes are also presented as fully as possible to take any extra work out of the equation for those on the fence about implementing the plan.

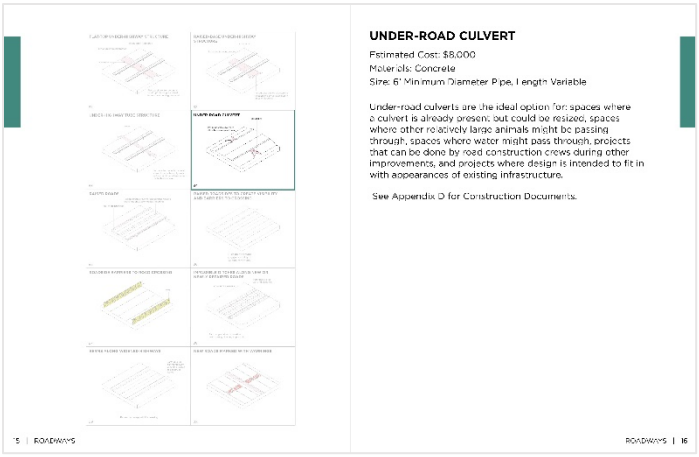

Figure 26. Mock-Up of Handbook Layout

CHAPTER 6: CONCLUSION

To support the continued survival and well-being of the Louisiana black bear, this thesis not only proposes a series of landscape interventions, but also clearly lays out a map of where to best locate interventions, offers prototypes of design sites, and packages these proposals into a handbook that can be readily understood by decision-makers. Through intentional rethinking of space, the bear would be able to travel between and beyond existing subpopulations and better track its suitable climate without conflict. By considering both current and future conditions, these designs actively make space for an animal that otherwise has had to navigate spaces created primarily for humans.

Though the fate of the Louisiana black bear drives the creation of these designs, their impacts are much broader. In terms of biodiversity, conservation of an umbrella species like the bear would also bolster conservation of numerous other species. In terms of resilience, conservation of the bear's preferred habitat, bottomland hardwood forest, would help protect Louisiana from the impacts of major catastrophes. In terms of culture, a shift in spatial occupation and prevalence of the Louisiana black bear could foster less fear and more appreciation among humans. Calling back to and building upon its teddy bear history, the Louisiana black bear could even become a symbol of wildlife conservation in the time of climate-change.

Next steps for full implementation of this project would entail not only working with state organizations like LDOT and LDWF, but also talking with farmers in the area to discuss the mutual benefits that would result from adopting some of these design interventions and policies on their private land. Because agricultural fields make up such a large percentage of land in this area, and Louisiana black bears are known to feed on crops and therefore frustrate growers, cooperation of local farmers will be crucial in reducing conflict and allowing for peaceful cohabitation on a long-term basis. Continued discussion between landscape architects, wildlife ecologists, and landowners is crucial for successful implementation of the strategies outlined in this proposal.

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FIGURES 3 -5

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FIGURE 6

Atchafalaya Basin Floodway:

Adapted from: "Map of Louisiana indicating the location of the Atchafalaya Basin (shaded), study area (rectangle), and location of gaging stations; 1, Atchafalaya River at Simmesport; 2, Atchafalaya River at Morgan City; 3, Wax Lake Outlet at Calumet, LA; 4, Butte La Rose (stage only)."

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FIGURE 16

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FIGURE 17-19

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